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THE USE OF PICTORIAL SYMBOLS IN THE COMMUNICATIVE PROCESS WAS EXAMINED TO ENHANCE ASSOCIATED TEACHING AND LEARNING CONCEPTS. THE ANALYSIS WAS APPROACHED BY PROVIDING EMPIRICAL DATA ON CONCEPT FORMATION, SEMIOTICS, AND THE COMPARATIVE-DEVELOPMENTAL APPROACH. ACTIVITIES INCLUDED--(1) EXAMINATION OF THE RESEARCH IN THE PICTORIAL AND MEDIA REALMS, (2) PRESENTATION OF A METALANGUAGE FOR CATEGORY DESCRIPTION, (3) COMPARISON OF WORDS AND PICTURES AS LINGUISTIC PHENOMENA AND WORDS AND PICTURES WITHIN CONCEPT ATTAINMENT, AND (4) DEVELOPMENT OF STRATEGIES TO OVERCOME THE DIFFICULTIES OF PICTORIAL RESEARCH. CONCLUSIONS SHOW POSSIBILITIES FOR EXTENDING CROSS-DISCIPLINARY DESCRIPTIVE WORK ON QUESTIONS IN THE REALM OF PICTORIAL COMMUNICATIONS. (RS)

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A Socio- and Psycho-Linguistic Theory of Pictorial Communication

James Q. Knowlton

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CORRECTIONS TO:

A SOCIO- AND PSYCHO-LINGUISTIC THEORY OF PICTORIAL COMMUNICATION

by James Q. Knowlton

The following is a list of some of the errors in the above-described monograph. The author will appreciate being informed of other errors, not indicated below.

page	line	error	should be
1.1	11	those	these
1.11	16	definitions	definition
1.2	6		accomplishment
1.13	17 and footnote	2.2	2.4
1.17	14	pictures	"pictures"
2.4	18	picotrial	pictorial
2.8	11	optional	optical
2.16	Table 2.1	margin	--
2.18	13	2/1.	2/1,
2.24	8	and	an
~~2.23~~	~~13~~	~~Halbert~~	~~Halpert~~
2.28		comes after 3.27	
3.13	Figure 3.1	Figure 4.2	Figure 3.1
3.20	Figure 3.2	Figure 4.1	Figure 3.2
3.28	Figure 3.3	Figure 4.3	Figure 3.3
3.28		missing	
3.32	24	distinoticn	distinction
4.5	Figure 4.1	Figure 4.4	Figure 4.1
4.5	1	(second) sign category	Referent category
4.8	17	conept	concept
4.11	21	if. . .icons depend	if iconic signification depends
4.12	Figure 4.2	Figure 6.4	Figure 4.2
4.16	Figure 4.3	Figure 6.5	Figure 4.3
4.21	Figure 4.4	Figure 6.2	Figure 4.4
4.26	20	perdicated	predicted
4.32	11	capicitors	capacitors

page	line	error	should be
4.43	10	igonred	ignored
4.45	4	strickly	strictly
4.63	24	paragrphs	paragraphs
5.12	22	(1960	(1959)
5.13	1	unsharped	unshaped
5.13	10	(1960)	(1959)
5.16	20	(1958)	(1959)
5.19	Pagination	5.19	5.18 + 5.19
5.22	1	(This	This
5.24	5	Then	Than
5.48	Figure 5.4	Figure 5.3	Figure 5.4
5.53	Figure 5.5	Figure 5.4	Figure 5.5
6.17	6 & 7	Omit last word, line 6, through the third to last word, line 7.	
6.18	16	Madamard	Hadamard
6.23	begins, 8	—	add brackets
6.25	19	area	areas
6.32	7	dimilarly	similarly
6.32	15	"elements,"	"element,"
6.34	end of quote	p. 22.	(p. 22.)
6.34	next to last	types	type
6.36	22	speaker	speakers
6.36	23	sytologists	cytologists
6.37	23	Hope	Hopi
6.37	24	language	languages
6.43	20	sybol	symbol

page	line	error	should be
6.44	4	behicle's	vehicle's
6.44	12	situation	situations
6.46	4	unstructures	unstructured
6.56	25	Add "quantization of" between "The" and "meaningful."	

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James Q. Knowlton

November, 1964

Division of Educational Media and
Audio-Visual Center, Indiana University
Bloomington, Indiana

PREFACE

In casting about for a way, briefly, to describe what I have tried to accomplish in the following pages, I discovered that my task had long ago been accomplished for me by Antoine Lavoisier, in his Preface to his Elements of Chemistry, published in 1789. The following sentences are Lavoisier's.

> When I began the following work, my only object was to extend and explain more fully the memoir which I read at the public meeting of the Academy of Sciences in the month of April, 1787, on the necessity of reforming and completing the nomenclature of chemistry. While engaged in this employment, I perceived, better than I had ever done before, the justice of the following maxims of the Abbe de Condillac, in his LOGIC, and some other of his works.
>
> "We think only through the medium of words--Languages are truly analytical methods.--Algebra, which is adapted to its purpose in every species of expression, in the most simple, most exact, and best manner possible, is at the same time a language and an analytical method.--The art of reasoning is nothing more than a language well arranged."
>
> Thus, while I thought myself employed only in forming a nomenclature, and while I proposed to myself nothing more than to improve the chemical language, my work transformed itself by degrees, without my being able to prevent it, into a treatise upon the elements of chemistry.
>
> The impossibility of separating the nomenclature of a science from the science itself is owing to this, that every branch of physical science must consist of three things: the series of facts which are the objects of the science, the ideas which represent these facts, and the words by which ideas are expressed. Like three impressions of the same seal, the word ought to produce

> the idea, and the idea to be a picture of the fact. And, as ideas are preserved and communicated by means of words, it necessarily follows that we cannot improve the language of any science without at the same time improving the science itself; neither can we, on the other hand, improve a science without improving the language or nomenclature which belongs to it.

* * *

The following pages record an attempt, in the spirit of Lavoisier, to develop a metalanguage for talking about pictures. A metalanguage, of course, is a language used for describing a second, or object, language: in this case, a "picture language." A careful metalanguage aids thought. For example, one will often describe English (as object language) using the terms of vernacular English; but whenever care, in thought, is demanded, it becomes necessary to supplement vernacular English with the specialized language of grammar or of linguistic science.

The need for technical terms in science is obvious. A concept that it is useful to employ, is often one that is not named by the vernacular language--i.e., the concept does not exist in the vernacular. Or if it does, its boundaries, typically, are vaguely or ambiguously drawn. And when the object of one's study is a language or quasi-language, as in the present case, additional complications often obtrude.

I believe it will become evident that the addition of a bare handful of metalanguage terms will make it possible to go a noticeable distance toward clarifying thought in the pictorial realm. That which can thereby be accomplished will be more than superficially similar to what Lavoisier tells us was accomplished for chemistry in 1789. Of course chemistry in 1789 had a much more significant core of hard empirical data to go on, than has accrued to pictorial "science" through mid-20th Century. And the lack of a hard core of empirical data does place severe limitations on what one can hope to achieve through an undertaking such as the present one.

The most optimistic goal I have had in mind, is that of discovering better questions for research than have usually been asked. (This is not so little a matter as the uninitiated are often inclined to believe.) A more readily attainable goal is the achievement of an understanding of the character of some of the erroneous thinking that has led to so many research failures in the pictorial realm so as to avoid compulsive repetition of this sort of faulty thinking. I believe that visible progress has been made toward both goals.

As so many writers are fond of noting, we all stand on the shoulders of giants. But some times it is difficult to tell which particular giants are holding most of one's weight; or, indeed, whether certain of one's intellectual benefactors is a "giant" at all. All of us, of course--and this includes the giants, themselves--stand also on the shoulders of average-size men. In my own case, at least, I feel special intellectual debts to quite a range of persons, both "giant" and "non-giant."

Lester Essig, Terumi Nakano, Don Payne, John Peterson, and William Smith--all former or present students of mine who have had special interest in problems of the sort herein described--have each taught me a great deal. Each has worked (or is working) on a doctoral problem in the general area of interest represented in this monograph.

Three of my colleagues have been especially thorough-going and helpful in their criticism; and each of the three has thereby been responsible for the clarification of ideas that, otherwise, would have been left unnecessarily vague. To these colleagues--Harvey Black, Malcolm Fleming, and Lawson Hughes--I wish to express my appreciation.

Very special thanks are due Raymond C. Miles and Moshe Anisfeld for helpful and sympathetic criticism of those parts of the monograph where it was necessary for me to try and speak outside my area of special competence, and where, therefore, I was more than usually likely to be guilty of careless thinking.

The briefest perusal of what follows will make obvious my intellectual debt to Jerome Bruner, Roger Brown, Charles Hockett, Susanne Langer, and Charles Morris. Less obvious, perhaps, but only a little less significant, is my debt to Joseph Church and Lev Vygotsky. In attempting to speak upon matters in several disciplines, I have sometimes been unable, with profit, to employ original papers. A secondary source sometimes provided an easy interpretation of the work of a pioneer that I found especially helpful; and in several such cases I have felt justified in neglecting the original work in favor of the later interpretation.

There are two persons whose names do not appear in the list of references, but who have nevertheless had an influence upon the form the monograph has taken. One of these is the late Professor Franklin Fearing, the other is Doctor Moshe Anisfeld. Professor Fearing was my mentor in graduate school, and his influence has been too pervasive to allow me to acknowledge him as fully as I should like.

As earlier noted, I was fortunate in obtaining the services of Moshe Anisfeld as a reader of the monograph; but Doctor Anisfeld also influenced me in yet another way. It was my good fortune to be able to sit in on Doctor Anisfeld's course on language and psychology, which he taught at the Linguistic Institute at Indiana University during Summer Session, 1964. Indeed, I learned so many things from Doctor Anisfeld that were quite new to me, that I had to stop writing for a while in order to reorganize my thinking.

I suppose a writer is never able to agree to the validity (or, perhaps, the significance) of all that his consulting readers suggest to him; and thus arises the necessity of absolving each of these greatly appreciated consultants of any responsibility for errors I may have allowed to persist.

So often, over the past year, I have commented to John Peterson that I wish it were possible to come up with an illustration of this or that idea, but that I could not see how it could be done. Peterson, who did the art work that appears in this monograph, always succeeded in such cases. He always found a way to illustrate the "un-illustratable." This fact may or may not prove something about pictures; but it proves beyond doubt, Mr. Peterson's ability as an artist. I wish to extend warm thanks to John Peterson for the contribution he has made to this monograph.

James Q. Knowlton

Bloomington, Indiana
November 1964

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1.0 INTRODUCTION

Pictures are sometimes extraordinarily useful in instruction. This much seems clear. However, a study of the research literature reveals just as clearly, that we do not know in any precise way why this is so, nor under what conditions it is indeed so. We really have no idea of the range of possible contingencies upon which suspected uses might depend.

Sometimes there is impressionistically-based agreement that, in some particular instance, pictures have greatly aided the clarity or precision of a presentation; and these impressions are sometimes compelling. Sometimes, even, there is empirical evidence to this effect; that is, that pictures (with words) have performed a service more effectively than words alone could perform it. The results of those latter studies, however, are seldom generalizeable. Almost always, it seems, there are contingencies which eliminate the possibility of generalizing pictorial findings. (Some reasons for this are considered in Chapters Two and Six.)

There are difficult problems in experimental control in the area of our concern. Many difficulties, however, are artificial: they are rooted in implicit erroneous assumptions about the relationships that exist (or do not exist) between pictorial and verbal symbols. One such error, as explained later, arises because students of pictures have, in general, failed to understand that pictorial symbols are post-linguistic (or post-conceptual) symbols.[1*] This is to say that the fact of whether or not a pictorial symbol signifies some concept, dependsupon whether or not that concept has already been attained by the interpreter of the symbol. As we shall come to see, this last is preeminently a linguistic accomplishment.

There is, in general, a considerable degree of vagueness and ambiguity in the concepts employed in pictorial research, including noticeable vagueness and uncertainty about the distinctions within the pictorial realm that can most usefully serve to define fundamental units for analysis. A careful examination of certain of these ambiguous concepts can help alleviate this state of affairs. This, at least, is my thesis: a thesis for the reader to judge.

1.1 Orientation of the Monograph

About 300 years ago, chemistry was emerging into a science. The state of affairs at the time of the later alchemists and the early chemists was similar, in certain key respects, to the state of affairs that now exists in regard to studies in the realm of pictorial communication. In particular, there were three developments that occured early in chemistry that need now to occur in the realm of pictorial communication if the latter is to begin to achieve a scientific footing. These developments had to do

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[*] Superscript numbers refer to notes at the end of each chapter.

with (a) the determination of a fundamental unit of analysis, (b) the improvement of the language of chemistry, and (c) the development of conceptual schemes to aid the formulation of "good" questions for research.

1.1.1 The Unit for Analysis. Long before the emergence of modern scientific chemistry, the alchemists and ancients had discovered a number of elements. Some were of the sort that exist in nature in relatively pure form; but others, like iron, had to be isolated. Still, the discovery of these elements proved only a little enlightening to the alchemists. They did not really understand what they had done. They had elements and also the term "element," but not the concept of the element as a "primitive" or "simple" substance of the sort that was "perfectly unmingled," and that combined with other elements to form all "mixed bodies" (as Robert Boyle was later to describe the difference between elements and compounds). The alchemists had elements and compounds and they worked with both of them, but they had no basis for distinguishing between them. They were thus unable to separate the elements they had discovered from the compounds that were comprised of them, and thus to investigate the elements in terms of their underlying principle.

In the pictorial realm, things seem much as they were in chemistry prior to Boyle's time. Not only is there disagreement as to the nature of the most useful unit (or units) for analysis, but equally as often, there is a failure to recognize that a problem exists in this area. (For example, I have often provoked doubt as to my seriousness when questioning the utility of the concept "picture"; or when asking concerning the state of affairs that justify application of this term.) Such a situation is all the more surprising because good progress has been made in several related areas. The fundamental units of analysis for much of linguistic science, for example, are clearly explicated, widely agreed upon, and proven in practice. And the concept of "symbol" (or "sign": the distinction is made later), which is central in much of what follows, has proved useful to students of language working in widely varying problem areas, including students interested in pictorial communication. However the latter group has generally used the term symbol, without a clear understanding of the concept it named. This term, to many students of pictorial communication, has as little value as the term "element" had for chemists before the time of Boyle.

Thus in a text on nonverbal communication (Ruesch and Kees, 1956), the authors speak a great deal of "analogical symbols," but fail even to systematically distinguish between stimuli that function as symbols and those that do not. For example, these authors describe a fence around a person's property as being an instance of an analogical symbol, and they lump this and other such displays of physical objects, together with expressive gestures and with pictorial and other analogical signs, and treat this heterogeneous collection in an undifferentiated way. For these authors, the collection labeled "analogical symbols" includes very nearly all the perceptible world, minus only words and numbers.

1.1.2 The Language of Science. The modern-day recognition that the study of science includes, importantly, the study of the language of science, was explicitly recognized almost 200 years ago by Antoine Lavoisier. (See Preface.) A more recent, and historically most prominent example of the kind of difficulty such analysis has dealt with, involves the multifarious notions expressed by the verb "to be." This verb, in its several forms, signifies at least five different things. To illustrate, consider the sentence: *Cows* *are* *hairy*, *cud-chewing* *mammals*. This sentence states four distinct propositions.

Thus:	1-a	There *are* such things as cows.	1-b	Cows EXIST.
	2-a	Cows *are* mammals.	2-b	The cow IS A MEMBER OF THE CLASS designated "mammal."
	3-a	Cows *are* hairy.	3-b	One quality of cows, is THE QUALITY OF harriness.
	4-a	Cows *are* chewers of cuds.	4-b	To be a cow ENTAILS chewing one's cud.[2]

The single verb "are," in the original sentence, performs all the functions of "are" in the four derivative sentences in the left-hand column, above; while the four parallel versions in the right-hand column vary from one another in a way to highlight the several distinct meanings of this single verb. These meanings are the notions of *existence*, *class membership*, *possession of a quality*, and the logical notion of *entailment*. A fifth meaning was not illustrated. This is the use of the verb to assert *an identity*. For example: An "iconic sign" is the same thing as an "analogic sign." (That is, the two phrases are synonymous.)

We all of us implicitly recognize all these meanings. We discriminate between them all, taking our cue from the context of the assertion. But in the complex and subtle problem-areas of science, ambiguities of this sort can be, and have been, catastrophic. Thus Aristotle, and his followers for hundreds of years, failed to recognize the ambiguity illustrated, with untoward consequences for the development of thought.

My intention in this monograph is, first, to try to show some gains that come to thinking in pictorial communication when a unit of analysis such as that of "sign" replaces imprecise and vague notions such as "picture," "pictorial," "graphic," or whatever. I shall then try to show how one may exploit the logically and psychologically more sound sub-categories of this concept, sign. The sign category, and its relevant sub-categories, provide a sounder basis for analysis than do the categories named by the usual vernacular terms in this area, because the latter are not only vague, but often disjunctive and overlapping as well[3].

The concept of a sign category (with its various sub-categories), can readily be related to important and relevant data from comparative-developmental studies of learning, and to highly useful findings in linguistic science. This can be done in a way to increase precision in "pictorial language," and in a way to suggest important new questions for research. This, at least, is my conviction; but I have no illusions about being able to state "a theory of pictorial communication" in this process, as the title of the monograph would lead one to believe: and so a word in explanation.

1.1.3 Language Refinement and Conceptual Evolution. What follows is not a "theory," as that term is used by the scientist or philosopher of science. It would be more accurate to describe the following effort as a "meaning analysis," or as "logical explication" (Mandler & Kessen, 1959). The term "theory" was used because in its broad and vague vernacular sense, it (hopefully) conveys to the general reader, roughly what I had in mind. It remains to be explained, then, what is intended by "meaning analysis" or "logical explication."

A "meaning analysis" states the conditions that must be met before a term can, justifiably, be applied. All the sciences borrow terms from the vernacular, and, generally, such terms are initially vague and ambiguous. Until the range of conditions of a term's application is restricted, and until there is agreement as to what this range is, the term is of little value.

Of course, there is no magic in any particular term, as such. When one attempts a meaning analysis, the thing that is important is not the particular term one happens to choose, but the precision of description of the boundaries circumscribing the set of conditions that are said to justify the term's application. It is of course equally as important that the concepts thus identified interrelate in ways that suggest the probable "location" of "new facts"--a function of theory, or of "conceptual schemes" (Conant, 1948).

The terms of a science (meaning, roughly, the "facts" they name) do not exist independently of one another even in the early and relatively primitive stages of development of that science (or potential science). Rather, they relate to one another with varying degrees of precision, and in simple and complex ways, to form some kind of network, or pattern, or scheme, or theory. But if the terms are vague or ambiguous, some of the interrelationships will be very imprecise indeed: certain of them so much so, that their imagined existence will turn out to be fiction.

It is at the primitive stage of development of a science or potential science that a "meaning analysis" is, relatively, most important. The immediate gain of clarity in language that can sometimes be attained, guides the formulation of better questions for subsequent research. As just stated, it often becomes clear that a relationship previously believed to hold is seen not to hold; and, by the same reasoning, previously unsuspected relationships may gain visibility. If great care is taken in accomplishing a meaning analysis, so that all explication fits what has been firmly established as empirical fact, the emergent structures will sometimes have an empirical basis sufficient to justify the label "conceptual scheme."

1.2 Approaches to the Problem of the Monograph

Of course a conceptual scheme is like a little theory; its existence depends upon the prior existence of a certain amount of reliably established empirical data. Unfortunately there is precious little empirical data that is relevant, in any direct way, to the symbol functions of pictures. Even so, this problem-area is not the isolated, hanging-in-limbo sort of thing, that preceding sections may have implied. Problems in pictorial communication are, after all, problems in the study of behavior; and in the vast realm of behavior science there are many types of information that the student of pictures will find useful.

1.2.1 Concept Formation. For example, there is a large body of data in the area of concept formation; and we shall be concerned with this topic at several places in the monograph. At this juncture only one point merits attention: viz., that our primary interest is not in pictures; rather, it is in how pictorial symbols operate in the communicative process to facilitate the teaching or learning of concepts. Some of the writing that follows will nevertheless convey the impression that pictures, per se, are objects of primary interest. This is so because terminological problems, of discovering less vague ways to talk about pictures, often dominate. And in finding better ways to talk about pictures, it will quite naturally be necessary to talk about pictures, as such. The fact that so much time needs to be devoted to the metalanguage task is, I believe, a fair indicator of the state of our ignorance. But like the student of language behavior--whose interest in studying mounds of ink on paper is nil; but who does have an interest in people's responses to these mounds of ink once they come to function as symbol stimuli--so, also, must the student of pictures take behavior as his primary concern. The pictorial symbol, physicalistically conceived, has only secondary interest.

1.2.2 Semiotic. Another area useful to our purpose is "semiotic": a field of enquiry typically defined as the science of signs. The field of semiotic is three-part: there is concern with the relationships that hold between a sign and the thing for which the sign stands (i.e., semantics); with the relationships between different signs or, more particularly, with grammatical or other rules for combining signs (i.e., syntactics); and with the relationships between signs and the users of signs (i.e., pragmatics).

To call semiotic a "science" is to express a hope for the future, for this discipline has not yet reached the stage of development that would merit use of the "science" label. Even so, semioticians have said a lot that is important for the student of pictures to learn about. What the semioticians say is particularly important for present purposes because the concept of sign (or symbol) is central to most of what follows.

The reader will note a frequent recurrence in the following chapters of terms such as "picture," "pictorial,""word," "verbal," etc. Underlying this is an interest in two, more general, concepts that subsume the four concepts just mentioned. These more general notions are the concepts labled "iconic symbol" and "digital symbol." Roughly speaking, an iconic symbol is one that resembles that for which it stands. Pictures are thus one (but only one) instance of the broad category of symbols designated "iconic." Digital symbols, unlike icons, resemble only themselves. By definitions digital symbols are totally arbitrary. Words are one instance of the broad category of digital symbols.

Pictures and words are the most important exemplars of their respective (iconic, digital) categories. For this reason attention will often be directed specifically to pictures and words despite the earlier objection concerning the inadequacy of such terms for conceptual evolution. As already implied, the difficulty with such terms is that the concepts thus labeled neither compound nor fractionate in logical, readily-describable ways, to form more molar or more molecular units.[4] But a notion such as "picture" (or "graph," etc.), when conceived of as a particular type of visual-iconic symbol, no longer presents the same difficulty.

The reader will also notice that much attention is paid to pictorial-only (iconic-only) communication. This is done in order to magnify differences between digital and iconic symbols. The position will not be put forth that pictures alone, or any other type of iconic symbol, can provide a generally effective mechanism for communication. Indeed, we shall discover a fundamental characteristic of iconic symbols that limit them in this respect. But having granted such a limitation, I would stress my agreement with Morris (1946), that the full range of usefulness of iconic symbols has not been generally recognized or appreciated.

As was stated, the approach to pictures followed in this monograph is one that regards pictures as symbols (or signs). But there are many sorts of circumstances such that pictures lack any sign or symbol status. To explain this fully first requires a discussion of the concept of "sign"; but for now it is necessary only to indicate that while non-sign pictures may have utility in instruction, the present concern is not one that dwells on such functions.

1.2.3 The Comparative-Developmental Approach.

In later chapters I say some things about animal learning, and about how children learn to speak. This reflects an acceptance of the adage that the fish will be last to discover water. It has seemed possible to me that the student of pictures may suffer a fate similar to that of the fish--i.e., in being slow to discover the important functions of pictures--unless he learns to exploit the comparative-developmental approach to pictorial problems.

My intention--which, hopefully, will be realized in following chapters--is to show how knowledge of a particular kind of complex learning in animals will help us avoid certain "invalid questions" that have been asked concerning human behavior; and to show, as well, how a study of speech and of language learning will point up important characteristics of pictures.

1.3 Content of the Chapters

In the following chapter, research in the pictorial and "media" (2.2)* realms is examined. This research is notoriously deficient, methodologically; but our concern will not focus on this fact. Rather, the focus of our attention will be upon certain deficiencies in the very questions that have been put to research in these areas. (Of course the two things--deficient questions and deficient experimental design--are probably not unrelated phenomena.)

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*Numbered designations of this sort refer to the numbered sections of the monograph. Thus "(2.2)" is the section in Chapter Two wherein is explained the reason for using quotation marks around the term "media."

In Chapter Three a metalanguage is presented to aid us in talking about categories. This draws upon the broadly significant work on cognition carried out in recent years at Harvard by Professor Bruner and his colleagues. An explication of the most centrally important categories in the approach to pictorial communication adopted in the present monograph is also given there. These are the concepts "sign category" and "referent category."

Chapter Four discusses words and pictures (or digital and iconic symbols). Verbal language is given attention, but the discussion is always guided with an eye to making contrastive statements comparing verbal and pictorial symbols. It will be seen that iconic symbols are necessarily post-linguistic. That is, the potential of the iconic symbol for inter-personal communication (though not, perhaps, for intra-personal communication) is dependent upon the prior establishment of the concepts signified. This last is an essentially linguistic phenomenon.

Words and pictures are again discussed in Chapter Five; but this time within the framework of concept attainment. The attempt is made to bring to bear the ideas developed in the foregoing chapters, so as to better understand the functions of iconic

modes of representation in communication in general, and in instructional communication in particular.

In Chapter Six certain research strategies are discussed. These are strategies of a sort designed to overcome the logical and conceptual difficulties in the realm of pictorial research, that are explicated in earlier chapters.

Notes to Chapter One

1. In Chapter Three, a distinction is drawn between what are called "identity" and "equivalence categories." It may be the case that pictures can "signify" identity categories pre-linguistically.

2. This illustration is not a clear one. For example, it might be said that "To be a cow *entails* chewing one's cud"; but also that "The cow *is a member of the class* of cud-chewers."

3. There are many examples of the type of difficulty referred to. Thus in an anonymously authored Technical Memorandum (335--TM--4, prepared by the Division of Communications, University of Illinois, December 30, 1952), the author(s) set themselves the task of reviewing the research that deals with the uses in instruction of various types of representational symbols such as pictures and graphs. Although these authors do a better than typical job for this area--they at least attempt to set forth the boundaries of their concern--they nevertheless get involved in some near contradictions.

   For example, they define a picture as "an illustration which looks enough like the original object to communicate the image of the original to the reader. Pictures," they continue, "differ greatly in their degree of verisimilitude . . ." (p. 2).

While pictures are included in their review, the authors exclude nomographic and cartographic forms (e.g., maps and blueprints) on the basis that the reader has to learn certain conventionalized symbols before he can understand them. This decision might be a reasonable one were it not for the fact that the authors then go on to include graphs, bar charts, and other illustrations that convey "number and magnitude relationships." These latter are included without comment as to their relative degree of verisimilitude, relative to cartographic forms.

4. The work of Wittgenstein (1962), especially as interpreted by Stenius (1960), would seem to provide an exception to this statement. Stenius has attempted a logical analysis of pictures based on the distinction between terms and relations. A student and colleague of mine, Mr. Donald Payne, first called my attention to Stenius' work.

2.0 WHAT IS THE QUESTION?

> If we would have new knowledge, we must get us a whole world of new questions.
>
> --Susanne K. Langer

My opinion is that much research in the pictorial realm is sterile, and for the reason that invalid questions have often been asked. The objective in the present chapter is to try to substantiate this thesis. This necessitates a critical examination of pictorial and "media" research of the sort that has dealt with learning.

It will not be especially helpful to show that certain research questions are invalid (as this notion will be defined), if it does not become possible to understand what it is that has lead researchers to sometimes pose invalid questions in the first place. But since the kinds of questions a researcher asks are reflections of the conceptual scheme within which he operates, this understanding should come once an understanding of these conceptual schemes is attained.

In order to show certain relationships between particular conceptual schemes and the kinds of questions asked by the adherents of that scheme, it is first necessary to examine some common definitions of audiovisual communication. These definitions will be seen to be shorthand statements of the underlying conceptual structure. It will then be possible to examine the difficulties commonly to be found in research on pictures and on "media" of the sort that reflect the definitional status described.

2.1 Definitions of Audiovisual Communication

Three categories of definitions of "audiovisual communication" (or "audiovisual education") can be discerned. I refer to these as: (a) cone-of-experience definitions; (b) job-description definitions; and (c) definitions of audiovisual communication as educational technology. From the point of view of this monograph--that of furthering conceptual evolution in the pictorial realm--only the first category need be considered.

In their central meanings, a majority of a sample of thirty-five definitions I have collected and subjected to a content analysis, are "cone definitions." I have labeled them thus, because each such definition implies a conceptual structure similar to Edgar Dale's (1954) "cone of experience." The key concept in Dale's thinking is the notion of an abstract-concrete continuum. Reference is not (primarily) to superordination-subordination as is frequently intended by the notion of abstractness-concreteness, but to arbitrariness-lifelikeness. Dale's rationale stresses the advantages for instruction that accrue from the use of lifelike symbols.

The definitions I have classified as cone definitions are more finely classifiable as: (a) machine-listing definitions; (b) sense-listing definitions; (c) definitions by exclusion; and (d) a mixture of the above. The machine-listing category includes those definitions of audiovisual communication that list message-mediating machines and devices. A typical (synthetic) definition of this sort is this: audiovisual communication refers to the use, in instruction, of motion pictures, slides, filmstrips, stereoscopes, microprojectors, radio, recordings, posters, maps, exhibits, objects, models, etc. These lists are often quite long. The motion picture projector and television are frequently named; and, in general, one can discern a preference for devices capable of projecting visual images on a screen.

The machine-listing definition-makers I have encountered are not explicit as to why they have chosen the particular set of message machines that they happen to list. It is clear, nevertheless, that there is a strong preference for those devices which have the capability of mediating pictorial symbols. All lists contain an exception or two as, for example, radio. But it is defensible to say that the definition maker was giving at least implicit preference to a definition that stressed the value of lifelike symbols. This is why I have placed machine-listing definitions in the cone-of-experience category.

The sense-listing category includes those definitions of audiovisual communication which state that the message is audible or visible or both of these at once. A typical example of this is: audiovisual communication involves the use of materials that are presented to students through the senses of sight and sound simultaneously. Some of these definitions stress that more than one sense is involved, others stress the importance of the visual sense. Taken at face value, the big majority of sense-listing definitions define audiovisual communication so broadly as to include, for nearly all purposes, the whole realm of communication. This is because so very little can be efficiently encoded so as to be perceived by other than the eyes or ears. (Braille is, perhaps, the only important exception.) But although the vast majority of all communication is "audio" or "visual" or "audio" and "visual" in the central meanings of these terms, the intent of the sense-listing definition-makers is more narrow than this might suggest. The intent in writing sense-listing definitions seems not one explicitly designed to include reading, writing, or speaking, so much as it is one designed to express a judgement favoring message symbols that bear a resemblance to that which they signify. An examination of the writings of sense-listing definition-makers makes it abundantly clear that "visual," quite literally, means "pioctrial" or "graphic" or, more generally, "visual-iconic." For this reason I have included sense-listing definitions in the cone-of-experience category.

Definitions by exclusion are a third type of "cone" definition. The thing excluded is words. For example, audiovisual instructional materials might be defined as those materials which do not depend exclusively upon words or similar symbols in order to be understood. Pictures or other iconic signs are seldom mentioned, nor is it explained what kinds of symbols are to be regarded as being "similar" to words. Nevertheless, it is again clear, from context, that the kinds of symbols that are to remain as the special domain of audiovisual communication are pictorial or other types of iconic symbols. Of the three types of "cone" definitions mentioned, this last is most clearly placeable in the "cone" category.

There are, finally, mixed definitions. These definitions are compounded from a list of senses, a list of machines, and a statement to the effect that audiovisual communication is communication of a sort that does not depend primarily upon words.

"Cone" definitions have had a considerable influence upon research. This is because these definitions imply a conceptual scheme; one stressing the virtues of lifelike representation in the construction of instructional messages. And just as "cone" definitions have taken three rather different forms while stemming from the same root, so has research taken three different forms, each paralleling one or the other of the three "cone" definitions.

2.2 Message, Medium, and Lifelike Representation

An examination of Allen's (1960)[1] valuable review of research in audiovisual communication, reveals what one might expect from the definitional status of the field implied by the foregoing analysis.

The largest section, and the most important one from the standpoint of this monograph, describes studies of the effectiveness of audio-visual materials. Nearly half of a total of 343 studies that are cited by Allen, are cited in this particular section; and these are cited, because of repeats, a total of 226 times. A number of interesting things are revealed by a count of the number of research citations given by Allen, under each of the several sub-headings that he used.

For example, more than 80 per cent (183/226) of the citations, are listed under sub-headings labeled with the names of message-mediating devices: primarily Motion Pictures and Television. This might be taken to reflect the machine-listing class of definitions described above. However, more than 90 per cent (169/183) of these "machine citations" refer to message-mediating devices capable of mediating pictorial symbols. (The exceptions: radio and records.) It is therefore obvious that there is an interest in pictorial modes of communication; and those acquainted with the field of audiovisual communication explicitly recognize a long historical precedent that is entirely congruent with this finding. It comes as something of a surprise, then, that Allen found only 19 citations to list under the sub-heading "Pictorial Illustration," and only 16 citations to list under the sub-heading "Graphic Materials." These two sub-headings are the only ones used by Allen that seem more relevant to messages than to media.

Pictorial and other lifelike modes of communication are of primary interest in this monograph. There is only a secondary interest in the message-mediating machine: one which arises because the various message-mediating devices vary in their potential for mediating lifelike symbols. However, the fact that some message-mediating machines can mediate lifelike symbols while others cannot, seems to have misled part of the research effort in the realm of our interest. In what follows, then, we shall consider more than pictorial research; we shall, in addition, consider certain problems that have arisen in "media" research. We shall see that the difficulties in the pictorial and "media" areas are strikingly similar, and that "media" research has not, in fact, been research on media. It will be our conclusion that the questions asked by "media" and pictorial researchers have been questions that were often either "invalid" or "faulty."

2.3 "Media" Research and the Invalid Question

Artists and others have sometimes asserted that "the message IS the medium." (For example, see McLuhan, 1964.)[3] I believe this is usually intended as a metaphor. Thus taken, this statement expresses a certain truth--viz. the point made above to the effect that different media place different restrictions on the kinds of messages they can mediate. In other words, there is a basis for a low-order correlation between message and medium; but it is important to recognize that this is indeed a low-order correlation; and that for one interested in teaching (learning), the message cannot be confused with the medium.

The preceding paragraph implies that there is an agreed-upon meaning for the term "medium." This, however, is not true. In communication contexts the term "medium" has been used to refer to any of several elements that intervene between a producer of a body of symbolic material (a message), and an interpreter of that message. And so the term "medium" has been used to refer to the air molecules whose movement carries speech sounds. "Medium" has also been used to refer to the sensory surfaces involved in receiving the message, or to some mechanical or optional or electronic device that carries messages. If the term "medium" is used in this latter sense, television and sound motion pictures will be regarded as two different media. If "medium" refers to the "channel," defined in terms of the sense receptor involved, then television, sound motion pictures, and gesturally-supplemented face-to-face conversations would all be said to involve the same medium: the audiovisual medium. The meaning of the term "medium" as used in the audiovisual field, seems clear from our definitional analysis; and as well, from our content analysis of Allen's review article. It would thus seem that "medium" refers either to some message-mediating device, or to the physical material introduced into such a device (the film, tape, etc.), but not to the message. However, we shall see that "medium," so defined, is at certain critical points confused with the message.

2.3.1 "Media" Research. Hoban (1961) has sketched what has been done in "media" research over the past forty years or so, and outlined the conclusions from this research that he believes have become generally accepted. The number of such conslusions is put by Hoban at a "half-dozen or so." Only three of these, however, seem relevant to media, conceived of as message-mediating devices. We begin with an examination of these.

One such "research conclusion" stems from what has been called "comparative media" research. This type of research has been popular in the audiovisual field: approximately one-fourth of the studies reviewed by Allen (1958) involved either the comparison of one medium with another, or the comparison of some medium (usually motion pictures or television) with "conventional classroom procedures."

The results of this very considerable research effort have been summarized by Hoban (1961) as follows: "There is little firm evidence in the research literature that any medium of instruction is intrinsically or invariably superior to any other medium in instruction" (p. 23, Hoban's emphasis). Hoban reasons that this is so because ". . . the media are not one-dimensional. Books include pictures. Motion pictures and television include pictures, language, music, and ambient noises. Filmstrips include pictures and print" (p. 13).

In thus ascribing a lack of unidimensionality of media (i.e., of such things as motion pictures, books, television) as being due to such differences as those between pictures and words (i.e., to something more akin to message variables), Hoban indicates that researchers in this area may have failed to draw any fundamental distinction between these two categories. But if differences between media are confused with differences such as those between pictures and words, for example, it is quite clear that any "media" study that results thereby, will be incapable of providing any evidence unequivocally revealing of anything at all about media, as such.

The two remaining "media conclusions" are these: "There is reason to believe that media are complementary, not competitive, and that a combination of media in the instructional process is superior to any one alone" (Hoban, 1961, p. 14). And: "Intermedia effects tend to be cumulative. The combination of motion pictures and reading materials, for example, has been shown to be instructionally superior to reading materials without motion pictures" (Hoban, 1961, p. 14).

These conclusions are two variants of a single notion. If media are complementary, they can only be complementary because the "media effects" complement one another, hence cumulate. What is it, then, that can usefully be said with regard to this "research conclusion"? If one makes a distinction between "message" and "medium," it would be fair to say that this conclusion is nonsense. Whether media are complementary or not, or whether "media effects" cumulate or not, depends upon whether the messages mediated thereby sustain and complement one another, whether they contradict one another, or bear no relationship to one another.

It will be well, now, to speak more generally. If one were to seek an answer to the "comparative media" question through a controlled experiment, one's independent variable would be stated in terms of some medium difference. One's dependent variables would be measures of learning. If adequate experimental control was maintained, the only thing that would be allowed to vary would be a single medium variable, hence all message variables would have to remain constant in the two conditions. One may doubt that this could be accomplished. If it could--i.e., if the message could be held constant while the media differed--the two learning outcomes would be the same. However, such a question would have no interest, for no one would urge that the message is unimportant in determining what is learned; and put thus, no researcher would be so naive as to conduct a "comparative media" study. Nevertheless, many such researches have been conducted. How is one to explain this?

It must be admitted, first, that there is an unresolved problem in the foregoing analysis: one concerning the definition of "same" and "different" with respect to messages. It is a problem that involves the manner one has decided upon for determining the meaning of a symbol, and we cannot tackle this problem at this point. (See Section 3.4.4.1 for explication of this point.) I believe, however, that the major outline of the difficulty we are considering is clear. If so, we are in a position to consider a possible source of this difficulty.

I would offer the suggestion that questions put to research in the "media" realm have often been "invalid questions." By an invalid question, I mean to refer to a question that contains an invalid assumption. The point is best illustrated. Consider, for example, the question: "When did you stop beating your wife?" This is a question that is invalid in many cases of its application. If the person questioned has no wife, or if he has, if he has no history of having beaten her, the question is invalid. This often-used example is a very good one, for the difficulty in the question is immediately apparent.

The response elicited by a question may be a *direct answer* to that question. Sometimes, however, the response elicited may be *a denial of the question*. Thus a person who has never beaten his wife will answer neither "yes" nor "no" if asked whether or not he stopped beating her. If he were to answer in either of these ways he would be agreeing with the implicit invalid assumption that he had indeed beaten his wife in the past. A person who was asked this question would deny that the question applied to himself. Such a person (though, perhaps, with different words) would assert that the question was invalid as applied to himself. In brief, such a person implicitly recognizes that a direct answer to an invalid question must itself be invalid.

The "comparative media" question bears a perfect analogy to the "wife-beating" question, for it contains an invalid assumption:

the assumption that message and medium are highly or perfectly correlated. If not this, this question confuses message and medium, or it assumes that the message is unimportant, relative to the medium. Unfortunately, the research result yielded when an invalid question has been put to empirical test, cannot issue in the form of *a denial of the validity of the question*. Rather, the form of an empirically derived answer to both valid and invalid questions, is the same: a "yes" or a "no." That is, a difference is observed or it is not. A difference is significant at some pre-determined level of confidence, or it is not. Thus--and although many studies may have been conducted in the search for an answer to an invalid question--the end result, *necessarily*, is either ambiguous or false. If both significant and non-significant results have been found, and if the direction of the difference has sometimes taken one direction, and at other times, a different direction (as has been the outcome in the case of "comparative media" studies), one is left where he began. This is a more desirable state of affairs than is the case where consistent results are found. For if the question contains an implicit invalid assumption, a consistent "yes" or a consistent "no" are equally invalid answers, and a false conclusion is thereby indefinitely maintained.

2.3.2 A Typical Research Paradigm in Studies of "Media." Before passing judgment on the foregoing analysis, it is necessary to examine what has been done in research of the sort upon which

Hoban based the conclusion that no medium is invariably superior to any other medium. Interest in the present section is directed at trying to understand the nature of the question that prompted this major empirical effort in the "comparative-media" area, especially when considered in light of the logically faulty basis upon which this research was founded.

One of the most frequently encountered variants of this type of research is one wherein the question asked, essentially, has been this: If the conventional classroom procedure is modified through the addition of a film (TV, etc.), will the amount the student learns be thereby increased? Some 63 of 83 "comparative media" studies reported by Allen were of this type: it was the addition of a film (TV, slides, etc.), not the addition of a message variable, as such, that was conceived to be the variable under investigation.

Let us assume that the two comparison conditions are (a) the conventional classroom procedure; and (b) the conventional classroom procedure plus film. The conventional classroom procedure will be designated the "A" condition. When film is added, this will be designated the "A/B" condition. It is frequently the case that time is held constant in studies of the sort here described, and so this condition is assumed in the following development. Because the time is constant for the two conditions, the amount of time required for the film presentation is gained by reducing the amount of time that otherwise would be given over to the conventional classroom presentation.

It will be useful to adopt a shorthand notation, and to represent, in tabular form, several of a very large number of possible situations. This has been done and is presented as Table 2.1. The ideas or concepts or skills that are to be presented in the film or by the teacher, are designated with lower case letters. Then, listed in parallel columns, are a few of the large number of possible differences that logically might exist between the "T," and the "F/T," conditions.

In situation #1 (Table 2.1), the "a-b-c ideas" presented by the teacher, or the "x-y-z ideas" presented in the film, may either one or both of them be relevant or extraneous to the achievement of some instructional objective. Depending upon the case, the implications are quite different. The film may be either extraordinarily valuable, or it may be worthless. The teacher may have performed well or poorly. But whatever the outcome, it is an outcome independent of any variable intrinsic to the film medium *qua* *Medium*.

In this same situation (#1), the "x-y-z ideas" presented in the film may represent the presentation of concepts important and relevant to "a-b-c," but whose presentation is beyond the means of the classroom teacher to achieve. It is here that are to be found the unique strengths of the film *medium*. By means

	CONDITION "A"	CONDITION "A/V"		
Situation	Teacher Presents	Teacher Presents	+	Film Presents
#1.	a a b b c c	a b c	+	x y z
#2.	a a b b c c	a a b b	+	a a
#3.	a a b b c c	a b c	+	a b c
#4.	a a b b c c	a a b b	+	c c
.				
.				
#n.	a a b b c c	a a b b c	+	c

Table 2.1 — A paradigm suggestive of some of the many possible ways that a film message may "interact" with the instructional message contributed by the classroom teacher.

of slow motion, time-lapse photography, micro-photography, montage, and such else, it is possible, through film, to do a very great deal that cannot otherwise be done. Any outcome in a case such as this one, has obvious and important relevance to the film medium.

In situation #2 a decrement may result under the "A/V" or film condition because reduced teacher time resulted in the omission of the "c-ideas," and the film presented no "c-ideas." This might result from faulty film selection or from faulty utilization of the film. But whichever is the case in this respect, neither has any relationship to any medium variable.

In situation #3 the approaches of the teacher and the film might be different but complementary, and an increment in learning might then be observed under the film condition. On the other hand, the two presentations might be enough different in approach, vocabulary, or theoretical orientation, that a decrement would result under the film condition. Again, whatever the case may be in this respect, no characteristic of the medium, as such, is sufficient to account for the difference.

In situation #4 the teacher presents those ideas the film omitted. Because of reduced time in the "A/B" condition, the classroom teacher was able to present only four "ideas," and these four would seem wise choices. The outcome in this situation will depend upon whether the film or the teacher does a better job presenting the "a-ideas." If the producer of the film has had more time, money and help in preparing the film than has the classroom teacher in preparing his classroom presentation, any increment in learning might be attributable to these factors rather than to some unique property intrinsic to the film medium.

In situation #5 is represented a condition which might fail to give a statistically significant difference even though a real difference in favor of film did in fact exist. The point to be observed is that Condition "A" and Condition "A/B" hold most of their elements in common. There is a big overlap because the shared "A" component is so much larger than the non-shared "B" component. And so for Condition "A/B" to prove statistically superior to Condition "A" (when a real difference does, in fact, exist), the film would have to do a many times better teaching job than the classroom teacher. Otherwise this difference would not be visible.

To clarify: Assume that per unit of time, a film teaches twice as many facts (or other increments of knowledge) as does the classroom teacher. If an adequate research design were used, this large learning increment would be highly visible and statistically significant because the true ratio in favor of film is 2/1. In situation 3a, however, the apparent ratio is not 2/1, but 7/6—a very much smaller fraction. The latter ratio, although it is in a direction favoring film, is so small it would be unlikely to prove statistically significant.

Thus:

Condition "A"

Teacher:
a = 1
a = 1
b = 1
b = 1
c = 1
c = 1
6

Condition "A/B"

Teacher: — a = 1
a = 1
b = 1
b = 1
c = 1
+ film: — c = 2
7

In uncontrolled "media" research of the sort described, any of many factors could account for some particular research outcome; but only a small fraction of these relate, intrinsically, to any medium variable. There is no way to quantify the next conclusion, but if there were, it would be possible to say something like this: The probability that a statistically significant research finding is a finding dependent upon the medium variable under study, is one in a hundred. If this imagined probability figure were accurate, it would be necessary to find 100 "media" studies showing a statistically significant difference before one would have, on the average, a single study in which the noted difference was one dependent upon some medium characteristic.[4]

2.4 "Media" Research and the Faulty Question

"Media" research of the sort so far discussed, was research that employed some medium or media, but it was not research likely to reveal anything about the medium (or media) employed. (Thus the use of quotation marks about the term "medium.") However, three of the half-dozen conclusions from "media" research outlined by Hoban (1961), lack any sort of relevance to media. These conclusions all invite the same comment: that the questions motivating this latter research are "faulty," though not invalid.

To illustrate: "We are beginning to learn in media research that high motivation is a critical element in learning from the newer media" (Hoban, 1961, p. 14). Or consider this conclusion: "The research literature includes some data which rather convincingly suggest that the elaborate and time-consuming preparations involved in the production of instructional motion pictures, television, and programmed self-instruction contributes substantially to their effectiveness" (Hoban, 1961, p. 14). . . . However "Prolonged time and intense effort. . . are not sufficient in themselves to produce maximum instructional effectiveness of newer media in instruction. . . . The skillful and deliberate use of well known principles of learning and teaching. . ." are also necessary (Hoban, 1961, p. 14).

In reference to conclusions of this sort, one can only say that it would be quite a surprise if these things were not true. There is no reason to believe that the body of knowledge relating motivation and learning should suddenly be suspended because a "medium" was involved. It is no surprise that difficult tasks take time. And it is no surprise that the expenditure of time, as such, cannot guarantee effective completion of any task.

Hoban is aware of this. He expresses disappointment that forty years of research have yielded so little, and he states that anyone looking to media research for answers, will be disappointed. He believes most of the half-dozen "media" conclusions cumulating over those forty years were, in any case, "intuitively known" (Hoban's words) before any research was begun.

Of course History is clear that science cannot accept intuitions as valid until they are empirically verified, however "self evident" they may seem. (That heavy bodies and light bodies fall at the same speed; that white light is composed of all the colors of the spectrum; are historically significant "non-intuitions" that will prick the reader's memory to the point at issue.) But, I think, Hoban had something different in mind--something insightful and significant--when he chose the unfortunate term, "intuition." I believe he had in mind the idea that a certain research outcome may seem pedestrian when previously established principles make the outcome highly probable. Thus it is conceivable that the principles of motivation and learning as they are now understood, would fail when some new message-mediating device was employed in the learning situation. But this is only "conceivable." More realistically, such an outcome would be deemed so unlikely, that did it materialize, it would not be believed. It would not be believed even after it was several times replicated, and in variations, over a period of some years. History, again, is clear: an outcome such as this would not be believed until some acceptable explanation could be worked out to account both for the new finding--i.e., the one *vis-a-vis* media--and for the other "facts" of learning and motivation upon which the newly disputed learning or motivation principle was originally based (see, e.g., Conant, 1957). The important point, of course, is that there are probably more efficient ways to spend research dollars, than to re-establish the most firmly founded principles of learning and motivation for each extant medium, and for each new medium as it comes along: for 8 mm. film today, and 7 mm. tomorrow.[5] This, then, is one of the sorts of things I have in mind when I describe a question as "faulty."

2.5 Studies of Pictures

I have spoken of "media" research. While media were employed in studies referred to as "media studies," these were not, in fact, studies revealing of information about media. In turning now to studies of pictures, we do not turn to something as different as might be suspected. Indeed, a remarkable parallel awaits our discovery.

Studies that have sought to learn whether or not pictures aid a student in comprehending a printed message, have given answers that were sometimes affirmative, and sometimes negative (e.g., see the review of pictorial research prepared by the Division of Communications, University of Illinois).[6] The most typical procedure has been to present an illustrated text to one group, and the same text, minus illustrations, to a second group. After a certain length of time for study, the subjects are tested for their comprehension of, usually, the printed message.

If the picture-plus-text condition always proved to be superior to the text-only condition, this would fail to prove anything about the value of pictures compared to words. The "experimental" groups in these studies had the same identical text as the "control" groups. In addition, they had some pictorial material. If the additional space given to pictures in the "experimental" group, were given over to additional verbal explanation in the "control" group, the "control" or verbal-only group might have earned the higher scores.

A design symmetrical to that just described, would require that one group be a pictures-only group, and the other a pictures-plus-text group. (This, of course, has been done. See, for example, Halbert, 1943.) Still, if the latter group learned more, this, again, would say nothing about the relative utility of pictures and words. But let us look again at the question that those researchers asked. The question was whether or not pictures could add anything at all to the comprehension of a verbal message. Asked thus, the design used is "understandable." But this question is, I submit, a faulty question; and the obvious error in experimental design reflects a defect in the research question. That which is involved here is summarized in Table 2.2.

A glance at this paradigm shows at once that whether or not pictures increase the comprehension of a verbal message, depends upon how the illustrations relate to the verbal message: upon the manner in which "A" relates to "B." This relation may be of an additive sort, or it may be subtractive, or neutral. Indeed, it may be an interactive relation. To illustrate, let us assume that "A" alone is compared with "A" and "B" combined; and that "B" alone is also compared with "A" and "B" combined. It is possible that "A" alone and "B" alone could both be superior to "A" and "B" combined; and this seemingly strange outcome would in fact result if there were and "A" x "B" interaction resulting from pro- or retro-active inhibition, thus producing a decrement in learning.

Group	Stimulus Conditions	Learning Efficiency
"Experimental"	A & B	f (A) + f (B) or, f (A) - f (B) or, f (A) x f (B) or, f (A) ? f (B)
"Control"	A	f (A)

Table 2.2 -- Some of the ways a pictorial message might "interact" with an associated textual message. The notation in the right-hand column reads: "an additive (subtractive, multiplicative, unknown) function of A and B."

It will be worthwhile to detail this point. A picture might present information relevant to the topic of the text, or it might not. If relevant, the pictorial information might be redundant or it might present information not contained in the text. If redundant, the redundant pictorial information might add to comprehension or it might not. (A certain amount of redundancy is necessary in all communication, but if the printed text contained simply-presented information including an adequate degree of redundancy, additional pictorial redundancy might not contribute to understanding.) If the picture presented important information not presented in the text, this might be information that could readily have been put in verbal form, or it might not. If the pictorially-presented information could readily have been put in verbal form, and this were done, this might be accompanied by a reduction in the learner's interest and motivation for the task, or it might not. And so on.

2.6 Conclusion

I have concentrated on a narrow spectrum of studies. Other studies, guided by better questions, have yielded interpretable results. In particular, pictures may be useful in instruction because they arouse interest, gain attention, or in some other way influence the motivational state of a learner in a facilitative way. But clearly, there is a need for more sharply delineated conceptual structures to guide question-asking; and also, to guide the interpretation of results attained. We are, finally, in a position to comment on this last mentioned and most critical problem.

We have seen situations in both the "media" and pictorial realms where the question asked was such that one could accurately predict before any research was even begun, that conflicting outcomes would result. Such predictions are entirely safe in all those cases wherein an invalid implicit assumption is detected in the question put to research. Thus, over a series of such studies, one would anticipate getting a mixture of "significant" and "non-significant" outcomes; and in looking at these results, a student of the problem would therefore conclude that nothing had been demonstrated. That is, he would conclude this if he were aware of the logical difficulty outlined in foregoing paragraphs. But it is clear that most researchers in this area have not been aware of the problem described. I cite two examples to show this.

In an extensive review of studies made of the instructional value of film, the authors of that review concluded, on the basis of the research reviewed, that if appropriate and effective films are effectively used, such films will speed learning and facilitate retention.[7] That is, the effective use of effective films is effective. The second sentence above, is a close paraphrasing of what was offered as a research conclusion. The statement is valid, of course, but it is valid because it is tautological.

In another extensive review, the authors examined all the studies they could find that asked whether pictures, with print, made for greater comprehension than was possible with print alone. As the foregoing analysis would have predicted, some studies of this sort give affirmative answers while some give negative answers.

In summing up, the authors of this review conclude--and, again, this is a close paraphrase--that pictures can work to increase the understanding of a text, if the pictures and text have been specially combined in a way so that each helps the other.[8] In brief, helpful pictures are helpful. This is hardly a research conclusion: indeed, it is another tautology.

In both the "media" and the picture/text realms, the possibility that the "A" and "B" conditions will interact in non-simple ways, is altogether too likely; and not only in situations of the sort we have considered. It is even possible as between the verbal and pictorial components of a single film.

I cannot recall where I read the report, but there is a dramatic illustration of this point in connection with an early "March of Times" film: one about Hitler Germany in the early years of that madman's rule. The film was shot in Germany, and the commentary was added in this country. The visual was a record of a happy, well-fed, well-clothed people; of tree-lined streets and nice homes. It was a picture of a vital Germany that had lifted itself out of the despair of the first World War. The verbal commentary, on the other hand, was a biting indictment of a ruthless dictator, a totalitarian country, a potentially murderous enemy.

This film provoked a storm of letters in protest. Some of the protestors complained that the film was anti-German, others that it was pro-German. A part of the explanation is quite clear: this

PRECEDING PAGE MISSING

Notes to Chapter Two

1. Reference to Allen (1958), is to a preliminary version of the report he prepared for the Third Edition of the Encyclopedia of Educational Research (1960). I refer to the earlier version because this is the version upon which I performed a content analysis, some findings from which are reported in Section 2.2.

2. Since writing this, I have come across an excellent analysis of "media" research by Lumsdaine (1963). He shows clearly and forcefully a number of the points made in this section, and he goes much beyond anything presented here so far as methodological considerations are concerned. I have come to the same kinds of conclusions as Lumsdaine, without having made any very extensive effort to analyze the methodology employed in "media" research. As indicated at several points in this monograph, I have, rather, been influenced in my approach by Langer (1942), who stresses the importance of the analysis of the question asked of research. I have tried to see whether or not they contained implicit invalid assumptions. They do, as is made clear in the body of the text.

   Something of the point of view reached by Lumsdaine can be shown in a few words. He asks, "Can device-versus-device, media-versus-media, or media-versus-conventional experiments ever have utility?" His answer: "As a basis for scientific generalizations, no." (p. 598)

3. Marshall McLuhan (1964) has claimed that "the medium IS the message." A reader of McLuhan's book will quickly discover, however, that this catch phrase is used as a gimmick useful in dramatizing that author's belief that the medium, per se, is indeed important. As regards this last, McLuhan is of course correct. Still, his approach must be recognized for what it is, a "propaganda trick."

4. One of my consultants, although he subscribed to the logic of the point under development, believed that the arbitrarily chosen figure of 1/100 unduly exaggerated the probable state of affairs; that 1/50, say, would be closer to the truth. Some readers will agree with this estimate. For these I urge that a little thought upon the matter may suggest that the direction of error is in the other direction. Perhaps 1/200 would be a more accurate guess.

5. An excellent reference that is directly relevant to the problem under discussion, is Hoban (1960). Hoban comments, in that article, upon the ad hoc nature of so much "media" research.

6. The reference cited is Technical Memorandum 335-TM-4, prepared by the Division of Communications, University of Illinois, to the United States Air Force Human Resources Institute (Contract AF 18 (600) 335; 670-07, 52-24, December 30, 1952).

7. This conclusion was reached by Hoban and Van Ormer (1950) from their classic review of effectiveness studies of films. However, these authors should not be held accountable for this naive position today, as they have long since seen that this conclusion is tautological, not empirical. Unfortunately, the author knows many persons who still quote the Hoban-Van Ormer tautology by way of supporting the instructional value of film. The present writer, at an earlier time, was one of those persons.

8. This conclusion was reached by the anonymous authors of the report described in Note 6, above.

3.0 THE METALANGUAGE[1]

> With sufficient caution, the properties of language may help us to understand the structure of the world.
> --Bertrand Russell

> The woof and warp of all thought and research is symbols, and the life of thought and science is the life inherent in symbols; so that it is wrong to say that a good language is *important* to good thought, merely, for it is the essence of it.
> --Charles Peirce

The notion of "category" is fundamental to the metalanguage adopted here. For reasons that will become clear, we shall speak not of symbols and referents (except as this is a shorthand way of writing), but of symbol categories and referent categories. And, indeed, more pages will be devoted to the discussion of categories (or concepts), and to concept formation, than to any direct discussion of iconic symbols, conceived as physical stimulus objects (3.4.4).

3.1 The Concept of Category

A category refers to a collection of discriminably different "things" regarded as the same or taken as equivalent for some purpose. Thus "animal" refers to a large collection of discriminably different things, while "man" refers to a smaller sub-set of this collection. Whether or not man is "really" an animal is not a useful question, for the answer depends upon the categorizer's purposes. Thus it may be useful for the zoologist to include man in the category labeled "animal," and to treat man, fish, and ant as equivalent for some purposes. For the lawyer or moralist, it may be important to categorize man separately from all other animals.

Similarly, an educational technologist may find it convenient to categorize together as "instructional media," all message machines used in instruction; while a person interested in pictorial communication would have to insist on categorizing, separately, machines capable of mediating pictorial symbols and machines that cannot.

It was stated above, that a category refers to a collection of discriminably different "things." The term "thing" implies a concrete, bounded entity like an animal, a person, or a daisy. The world, of course, is also comprised of unbounded "things" (like air and water), processes (like muscle contraction, the movements of tide, growth), ideas and feelings. Thus the term "thing," enquoted, must be given this extended meaning. For simplicity sake, concrete, bounded entities are the "things" used in the illustrations that follow.

3.1.1 Equivalence and Identity Categories. Sam Smith, who is a particular specified person, is a member of the "man category." But Sam, himself, also comprises a category. There is Sam at birth, a different Sam at death, and there are a non-denumberable infinity of Sams in between. There is happy, ebullient Sam drinking champagne among friends on his twenty-first birthday; and depressed, sad, Sam, trying to get some work done at the office next morning. These and many more "different" Sams can be discriminated, though we think of all those instances as representing one and the same person.

Equivalence categories are named by such terms as "animal," "man," "media." Identity categories are named by such phrases as "Sam Smith's pet goat," "Sam Smith," "Sam Smith's new tape recorder"; or by such phrases as "that rose," "my house," "Mount Fuji." The elements comprising an equivalence category are recognized as being different, distinct entities; but as entities that are equivalent for some purpose. The elements comprising an identity category, on the other hand, are not regarded as distinct entities, but as varying forms (different versions) of a single entity.

Equivalence categories have generic names: for example, "animal." Many sub-sets of this category also comprise equivalence categories. "Livestock" names one such category. A market analyst, for many of his purposes, would group together those animals referred to as livestock, and treat all the members of this category as equivalent. A stockman, though interested in livestock, may raise only cows and horses and distinguish sharply between these in terms of feed and other needs. The stockman's son may be given a colt of his own to raise as his personal riding animal. "Topa" (as the stockman's son labels his new-born colt) names an identity category.

In using speech to refer to the "things" in one's world, one always refers to categories of things. This is not the case with pictures. A photograph of Mount Fuji, for example, is taken from a certain point of view at a certain point in time; but the un-modified verbal label, "Mount Fuji," refers to that certain mountain for all past and future time, in all stages of vegetable dress or undress, in all seasons of the year, from any and all or no particular vantage point.

It is in this light that Vygotsky (1962) has stressed that every word represents a generalization: all words name categories.[2] This is clear in the case of equivalence categories, such as "animal" or "man," and even of such narrower categories as those named "pencil" or "movie projector." However it is also true of categories named with proper names: that is, identity categories.

An individual person, for example, displays discriminably different moods, physiognomies, senses of humor, etc. According to some sociologists, each man plays as many different roles as there are significant persons in his life. He plays a different role vis-a-vis each such person. Sam Smith at church with his wife, and Sam Smith out on the town with the boys are discrimanately "different." Sam Smiths, though these several "versions" of Sam Smith are taken as different forms of the same entity. In brief, "animal," "pencil," "movie projector," and "Sam Smith" are all names of categories (or concepts).

This distinction between equivalence and identity categories has relevance for pictorial communication. A little reflection will thus reveal that a single picture cannot signify an equivalence category. A single picture cannot, with certainty, even signify an identity category. A photograph of Sam Smith, for example, can unambiguously represent only a single instance of the Sam Smith identity category: that is, it represents Sam at one certain moment in time. This problem is central to any discussion of pictorial communication, and it is analysed in detail in a later chapter.

3.2 The Definition of "Attribute"

To describe something requires that one analyze it in order to be able to say what the "parts" are and how they go together. As Boring (1942) has put it: "A house is walls, door, windows and roof, with the roof on top and the windows and door in the walls and not in the roof. A stone is shape, color, weight and kind of substance in complicated relations. When such descriptive ultimates are general properties which can vary continuously or discretely, when they are, in short, parameters, they may, if one chooses, be called attributes of the object described" (p. 19).

3.2.1 Formal and Functional Attributes. We shall thus use the term "attribute," and speak of two types of same: "formal," and "functional." Formal attributes refer to the perceptual qualities of objects such as color, size, weight, sound, texture, etc. that have the potential to act as discriminanda for sorting and re-sorting the objects in the perceptual world. Thus ripe apples, ripe tomatoes, and ripe cherries can generally be separated from their unripe counterparts by color; and apples can generally be separated from cherries by size and by configurational properties, or by taste, or smell, etc. Metropolitan opera stars can be categorized separately from the members of their audience, by their physical placement on the stage; and also (generally) by the timbre and other physical qualities of their singing voices.

To take another example: certain round dishlike stones might be categorized together because they possessed, in common, certain combinations of formal attributes. But for boys of cub scout age, these same objects might be similarly categorized on different grounds (or at least in different terms) as "sailing" rocks. In this last instance, these rocks are similarly categorized because they have a common function or use. They are missiles-to-be-thrown. The complex of formal attributes that add up to the special aerodynamic quality that "sailing" stones must have is, of course, their defining characteristic. But such stones would not ordinarily be looked at in such complicated terms; rather, they would be looked at, directly, in terms of their function as "sailers." Hence the reference to "functional attributes."

3.2.2 The Criteriality of Attributes. An attribute that has one value for all the members of a category, and a different value for all non-members, is an attribute that allows one to infer the category membership of a "thing" in an errorless way. We will say that such an attribute is perfectly criterial. For example, if all ripe tomatoes were red, and all unripe tomatoes green, one would have a perfectly criterial attribute for sorting tomatoes into ripe and unripe categories. One could do this in an errorless way by using two values (red and green) of the attribute, color.

But as the example chosen suggests, attributes are seldom perfectly criterial. Not all ripe tomatoes are red, and even for the standard variety that is indeed red when ripe, the color-change from green to red is as gradual as is the ripening process. It is therefore necessary to speak of the relative criteriality of an attribute.

A category is ordinarily formed on the basis of more than one attribute. The presence or absence of whiskers in the human adult, for example, is highly but not perfectly criterial for the task of sorting this collection into the categories male and female. Thus there is the bearded lady of the circus and the occasional adult male with no or little facial hair. Because of this, one would not ordinarily base his judgment of sex on the attributes of facial hairiness alone. Usually, one can accurately categorize even such extreme cases as the bearded lady of the circus, because several criterial attributes are taken in conjunction; and these will usually outweigh a single misleading attribute such as female beardedness. Differences in clothing, hair style, bodily configuration, manner of walking, etc. may any or all aid an observer to accurately categorize sexually anomolous human adults as male or female.

Attributes are either criterial or noncriterial. Noncriterial attributes, in turn, are either "noisy" or "quiet." Noisy attributes interfere with the categorizing task because they take more than one value for the members of a category, and they take these same values for non-members. Thus if a Martian, in trying to learn bases for distinguishing the sex of Earthlings, should try hair color, his taxonomic quest would be impeded because all hair colors found in males are also found in females. That is to say, hair color is noisy for this task. Quiet attributes, on the other hand, neither help nor hinder because they take the same value for all members of the collection to be categorized. Thus our Martian would neither be aided nor hindered by the attribute of two-legged-ness in his attempt to separate Earthlings, by sex. Two-legged-ness is noncriterial and quiet for this task.

Categories are human inventions, not inexorable "naturally existing" units or divisions of nature. Thus any collection of things can be sorted in very nearly as many different ways as there are different purposes motivating the sorting activity. The collection of adult humans can be sorted in terms of sex, number of dental caries, religious preferance, brain weight, attitude toward Communist Cuba, and so on indefinitely. As purposes change, attribute criteriality also changes. Thus two-legged-ness is noncriterial and quiet for categorizing according to sex, but modestly criterial for categorizing persons as physically handicapped or not physically handicapped.

3.3 Types of Categories

One way that categories can be distinguished, is in terms of the nature of the relationships that exist among the criterial attributes of the category. Three such merit attention: conjunctive, relational, and disjunctive. Conjunctive and relational categories are types commonly found both in the vernacular and in the language of science. The disjunctive category is found in the vernacular, but occurs in science as a source of error. Disjunctive categories are quite common in the pictorial and "media" realms, and so our interest in category metalanguage, at this point, is in showing the nature of this difficulty.

3.3.1 Conjunctive and Relational Categories.

A conjunctive category is one defined by the joint presence of two or more attributes. The category of "good apples" might thus be defined as including all apples that are ripe, and also wormless, and also of at least a certain minimum size. A relational category is one defined in terms of the relations existing between (or among) the criterial attributes. Thus the category of "shapely women" might be defined in such a way that to be included, a potential member must have a bust approximately equal to size of hips, with bust and hips being larger than the waist by some proportionate amount.

3.3.2 The Disjunctive Category. This category is defined in terms of alternatives. It is defined by the presence of either one (or a set), or another (or different set), or yet another (or third, etc.) set of attributes. Because of its relevance, a personal anecdote may, perhaps, be permissable in illustrating disjunctiveness.

When I was first introduced to the field of audiovisual communication, I asked a colleague what was included under that rubric. I was given, alternately, what was tantamount to a "sense-listing," a "machine-listing," and an "exclusion" definition as these were previously defined. I do not recall the order in which these definitions were offered, but say I was first given a sense-listing definition. This prompted a query asking the status of the case in which a teacher read aloud from the course textbook as the students followed in their own texts. Although this is a clear case of "audiovisual communication" in the central meaning of that phrase, it was denied as an instance of the "audiovisual" category.

An alternate definition that centered on the instructional device was offered next. However, further query revealed that microscopes, typewriters, slide rules, pencils, and such, had borderline status, if that: such devices, my colleague felt, were not generally thought to qualify for "AV membership."

Films did qualify. There was hesitancy, however, when I asked about the fitness of a filmed presentation of a printed text. (Of course, such a wasteful film would never be produced.) At this point, pictures were mentioned. Films are valued in large measure, for their pictorial element.

The difficulties my colleague faced in trying to inform me did not lie in any lack of knowledge on his part, but depended upon the fact that "audiovisual communication" has been widely conceived as a disjunctive category. Thus it emerged that an item could gain membership in the "AV category," if there was involved a message machine of the sort that projects the message upon a screen; or, lacking this, if the message was pictorial; or, if not this, if it was "programmed," etc. A category such as this one is disjunctive because the rules for determining membership take an "either this, or that, or that. . ." form.

Disjunctive categories seem unlikely to significantly interfere with the important work of the practitioner. The unaware researcher, however, is seriously affected whenever he employs a disjunctive concept as a variable in an experiment.

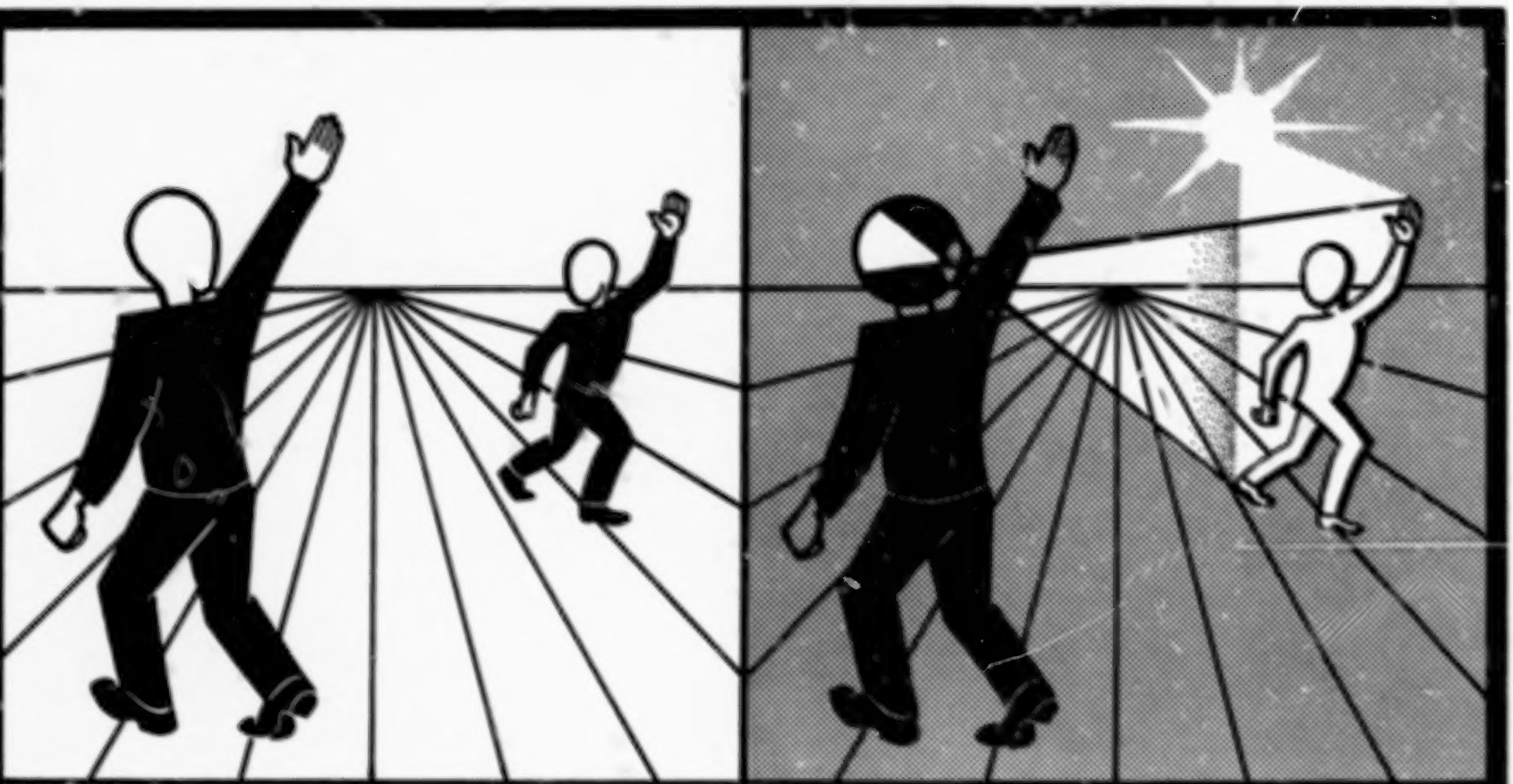
The point can be illustrated with a common sense example. The "strike" in baseball names a disjunctive category, but creates no special problems in the play of the game. However, if a coach wished to analyze what was involved in good pitching (or hitting), he could not use the notion "strike" as it is usually defined, because it is a confounded variable. It confounds what it is important to keep separate in analyzing batting skill: viz., the case where the batter swings at the ball and misses, with the case of a called strike, with the case of a hit into foul territory.

Similarly, if audiovisual communication were defined in the disjunctive way illustrated above, this would not stop the practitioner from "playing the game"; but a researcher who wished to analyze the "performance" of "audiovisual methods" would either have to redefine that concept to eliminate disjunctiveness, or be faced with a hopelessly tangled confusion of variables.

3.4 Signs: Signals and Symbols[3]

Man often responds directly to relevant aspects of his environment, as when he copes with an obstacle blocking his path by taking direct action in reference to that obstacle: by removing it or making a detour around it. But in man there is a prominent alternative to this sort of direct action. Reference is to indirect action through "signs."

To illustrate: if a tall fence happened to block the path of a small child, the child would probably make an effort to do something about this circumstance. If the child were alone, he



Sign stimuli may be of any sort that affect an exteroceptor;

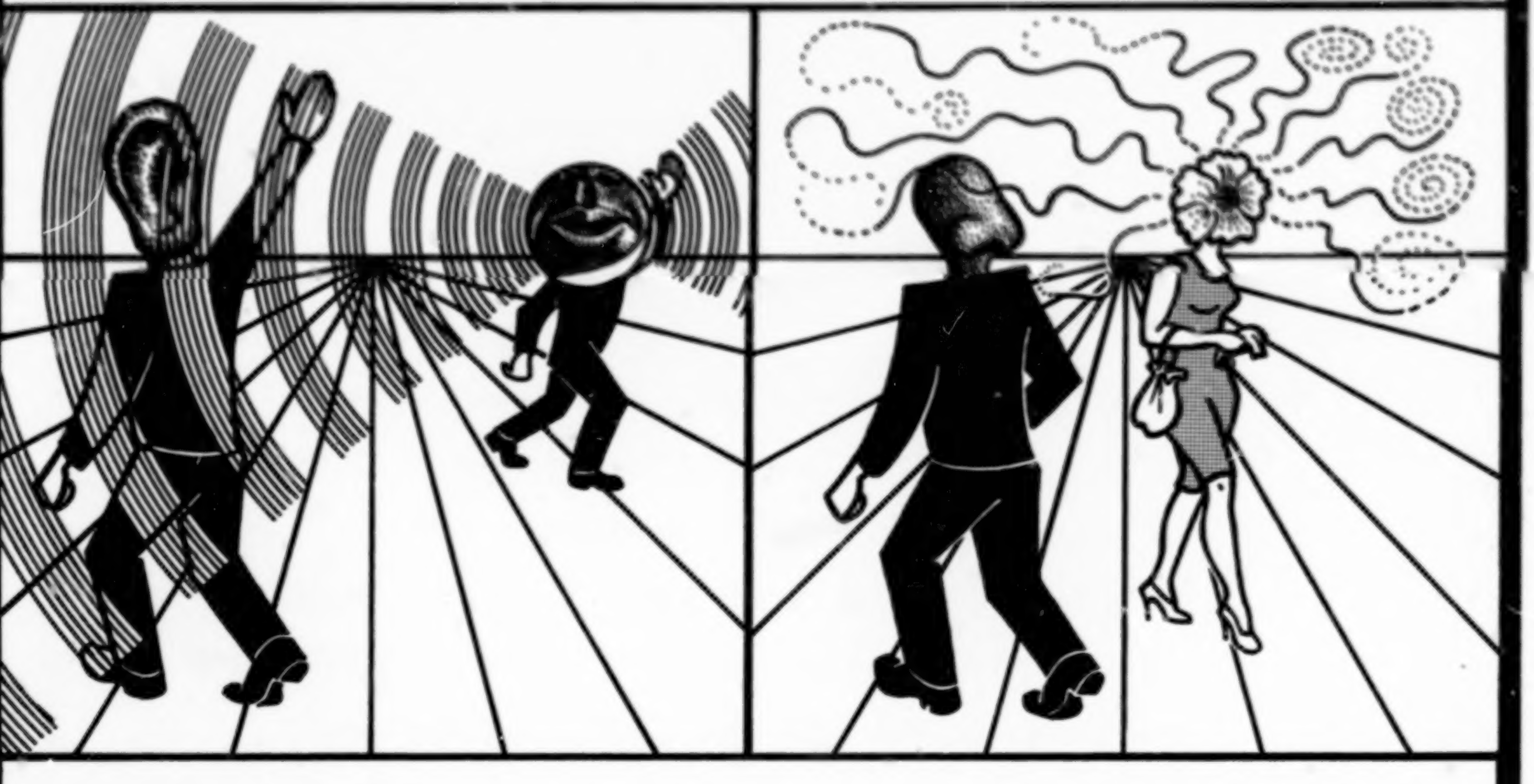


FIGURE 4.2 –but only the visual and auditory receptors are capable of making rapid and fine discriminations between stimuli originating at a distance.

might try to find a way around the fence, or perhaps through it. But if his father were in attendance, the child would be unlikely to cope with the fence directly. Rather, he would be more inclined to cope with it indirectly by means of a simple request directed to his very tall and compliant father. The child has learned that simple requests often produce the most remarkably effective results, and at a cost to himself amounting only to the minuscule expenditure of energy required for brief vocalization.

3.4.1 The Concept of Sign. The words spoken by the child are signs. But the concept of sign includes much besides words. One of two definitions of sign given by Morris (1946) is only approximate,[4] but it provides a good starting point. A sign is "something that directs behavior with respect to something that is not at the moment a stimulus" (p. 354). Thus a sign is a stimulus that functions in place of another stimulus. A sign is a sort of substitute stimulus.

Signs, being stimuli, are physical events of the sort that are capable of causing physiological activity in sensory organs. (This is a fairly standard definition of "stimulus," as see English and English, 1958.) It will often be useful to regard signs as physical stimuli in just this sense (though see 3.4.4).

Signs may be stimuli of any sort that can stimulate an external receptor. In man, though, visual and auditory signs predominate. Indeed, as is suggested by Figure 3.1, only the eyes and ears are capable of receiving stimuli originating at some distance from the receiving organism, and, as well, of making discriminations on the basis of small differences in these stimuli.

Signs were described as substitute stimuli, and as stimuli that "direct" behavior the way something else would if that "something else" were present to the senses. This is helpful. But different types of stimuli exert differing degrees of directness of control over behavior. That is, the influence of sign stimuli like the influence of all stimuli will vary, depending upon the contribution of central nervous system processes in shaping responses.

Signs have also been described as stimuli produced by one person to affect the behavior of another. This, too, is a useful way to regard signs, except for the fact that signs often fail to produce any effects that are observable. Indeed, there are no directly observable cause/effect relationships between signs and responses; and the indirectly observable relationships are only probabalistic ones. It may therefore be best to say (as does Cherry, 1957) that signs affect the state of an organism. (The italicised term does not rectify anything; but it does imply the fact of unobservability.)

The difference in specificity of control of behavior of the releaser stimuli that "unlock" "innate releaser mechanisms"5--which phrase translates, roughly, as "instinct"--and the specificity of control of behavior of the sign-stimuli of speech, is immense. More exactly, the consequences of this difference are immense.

All students are in agreement on this much; but as would be expected for the primitive state of behavior science, there is not agreement on how best to account for this gap.

Whatever one may wish to say about the manner of functioning of any hypothesized process believed to account for "stimulus control" of behavior, there are a few definite types of situations wherein the degree of directness of any such control can be seen to be widely variant. At one pole is direct physical action. This is a non-behavioral phenomenon, but it is one that provides a convenient anchor. Closest to this in the behavioral realm are, probably, innate releaser mechanisms and unconditioned or other "reflex connected" stimulus/response pairs. Such stimuli exert a sufficiently direct degree of control--in the sense that any contribution from the central nervous system is constant or minimal--that if the stimulus situation is known, the accuracy of response-prediction may very well be perfect.

None of the stimuli involved in the foregoing are here thought of as sign stimuli. Conditioned stimuli do so qualify, however, and conditioned stimuli should probably be listed next. The directness of the control over behavior that is permitted by conditioned stimuli is hardly such as to allow perfect or near perfect prediction of responses--not, at least, until one specifies the nature of quite a large number of variables.

The sign stimuli of speech seem to be quite another matter. Bloomfield (1933), among others, has remarked how difficult it is to predict the form of a person's verbal response. This is true even in the case where the predictor has intimate knowledge of the predicted person, his environment, and his present "state of mind." Even knowledge of the specific nature of a request a person would like to make is seldom sufficient to allow prediction of the particular set of words he will use: indeed, that he will even make the request in a given situation. The reasons for this are many but none are usefully to be commented upon here; still, the foregoing consideration does serve to dramatize how distant is the pole that lies opposite that of the innate releaser mechanism.

Two points, in conclusion: However different is the directness of control of the various kinds of stimuli discussed, the resulting responses will often appear on the surface to be remarkably similar. Thus to use an example of Cherry's (1957), one might push another into the lake, or request that he go jump in the lake. If, in fear, one's interlocutor complies with one's verbal request, the end result (at least in the obvious respects) would be the same as if one had pushed one's interlocutor into the lake rather than having talked him there: same end, but achieved by quite different means.

Finally (in reference to an earlier paragraph), it was said that signs direct behavior. It should be clear at this juncture, that the term "direct" is a compromise term. No single term adequately fits the slot between the terms "sign" and "behavior" when the need is to signify something of the nature of the influence of signs upon behavior. This is partly because the term "sign" is broad, and quite different sorts of stimulus functions are included under this rubric.

3.4.2 Signals and Symbols. Two broad sub-classes of signs are regularly distinguished by semioticians, though without high agreement as to labels. I follow Morris (1946) in choosing for these classes the labels "signal" and "symbol," though my manner of thinking about the implied distinction has perhaps been most influenced by Langer (1942).[6]

Signals and symbols are here distinguished in terms of two, non-independent, criteria: (a) whether or not the sign is a part of the condition signified; and (b) whether or not the sign is intentionally produced by its user to act as a sign. A sign will be identified as a signal, then, if it is part of the condition signified, but is not intentionally produced. A sign that is not part of the condition signified, and that is intentionally produced by its user to act as a sign, is here taken as a symbol. This may be diagrammed as follows.

		The sign is	
		(a) part of the condition signified.	(b) not part of the condition signified.
The sign is	(a) intentionally produced.		The sign is a SYMBOL
	(b) not intentionally produced.	The sign is a SIGNAL	

A signal is a part of a larger condition or state of affairs of which it signifies the remainder. The symptoms of a disease that a physician takes account of in making a diagnosis, are thus instances of the concept, signal. That is, the symptoms are an inextricable part of the larger state of affairs that is the disease, and they are not intentionally produced. Similarly, the physical condition of potato vines is related to the physical condition of the roots and tubers of which they are a part, and when a certain condition of the vines is manifest, this is taken as a signal that the potatoes are ready for digging. Or, again, sagging shoulders and a slowed gait are often a part of the condition of "tiredness," and are sometimes taken as signalling this condition.

If a person says, "The potatoes are ripe," these signs are symbols. They are not a part of the state of affairs they signify--they are separate from what they signify except for an arbitrary, learned association--and they are intentionally produced.

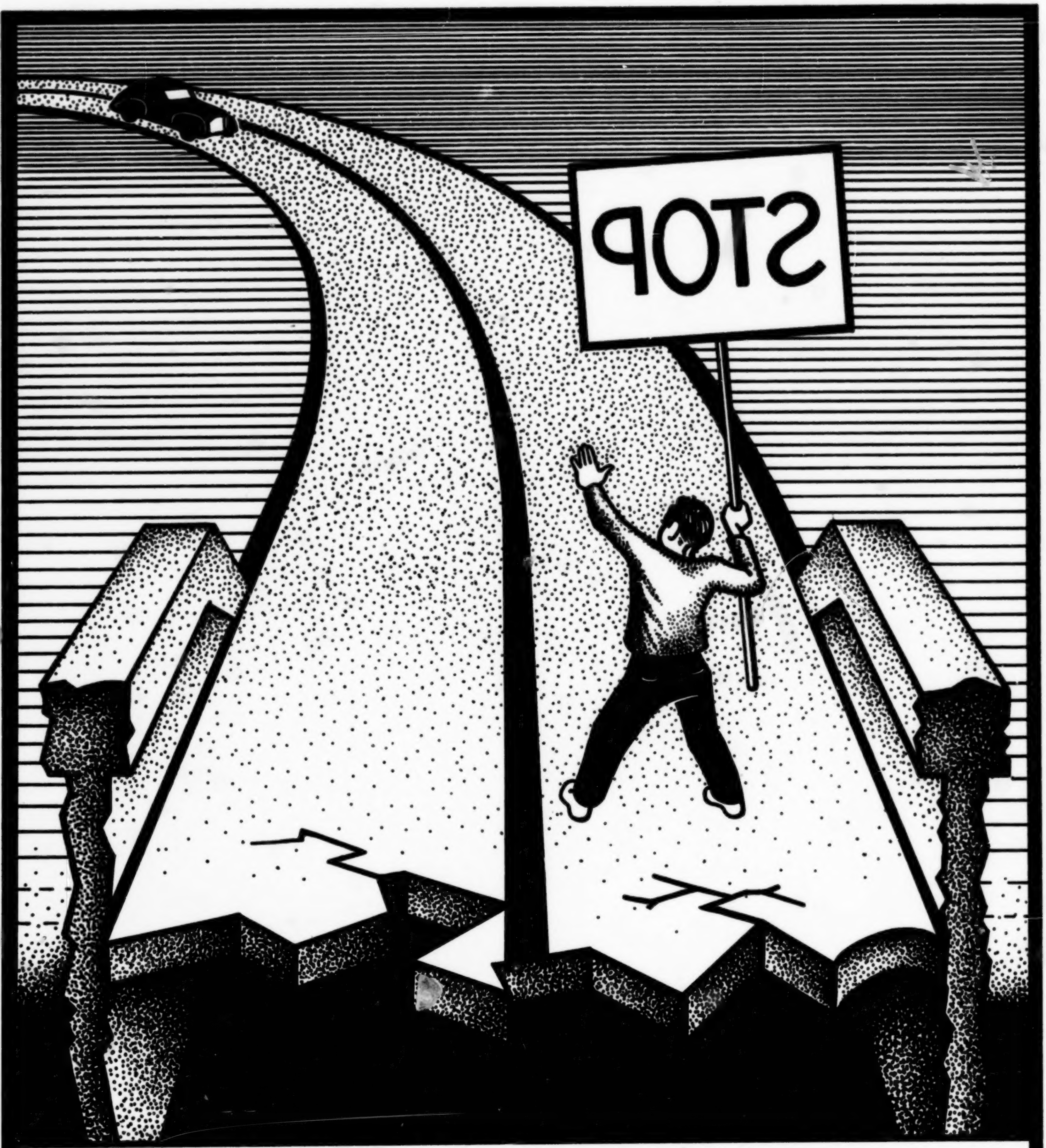


FIGURE 4.1 Sign stimuli as "substitute" stimuli.

The example given in the first paragraphs of this section, of the boy asking his father to lift him over the fence, illustrates the use of signs as symbols. It also illustrates what has been called the "triggering" characteristic of signs (Bloomfield, 1933; Hockett, 1960). To exploit the suggested analogy, consider that the energy required to pull the trigger of a gun would be insufficient to stop the charge of an enraged beast; but that the explosive force thereby released could achieve this end. Similarly with signs that are symbols: the energy required to produce a symbol is low, especially when compared to the ends symbol production can achieve.

Stimuli that function in the described "triggering" sense, and whose direct biological consequences are nil, are described by Hockett (1963) as "specialized." Thus signs (especially symbols) are trivial in themselves. They gain importance as substitute stimuli.

The substitute-character of symbols is illustrated in Figure 3.2. If there were no person present to alert the motorist depicted in this illustration, his behavior with respect to stopping his car would be guided by his perception of the washed-out bridge. But a warning person could secure this same "stopping behavior" at an earlier and safer point in time through the production of symbols. In the illustration the word "STOP," and, probably, the posture and arm position of the warning person as well, are symbols.

It was stated above that signs direct behavior in a way something else would, were this something else present to the senses. It should be clearer, now, that this is only an approximate description of the case. The driver depicted in the illustration would not know, for example, what was the state of affairs that prompted the sign-producer to signal him to stop; whereas, should the driver proceed to the bridge, he would know this. Of course, the sign producer could have added the phrase "bridge out," under the word "STOP," with a resultant increase in the driver's understanding of the situation. Even in this case, or in cases where much more complete information was given, signs, probably, would still not direct behavior in precisely the same way as would the referent of the sign.

3.4.3 Expressive Signals. We will see later that only man has language as the linguist defines this term. Of course animals other than man communicate, though not by language; and man, too, communicates in nonlanguage ways. It is therefore necessary to be clear as to the nature of a distinction between language communication and another form of communication that is sometimes confused with language. This will also help to further establish the distinction between signals and symbols.

An expressive signal is one that signifies something about its producer, without the producer intending that such be the case. For example, if a person is embarrassed, the embarrassment entails certain bodily changes; and one of these may be blushing. If this external manifestation occurs, it may be taken as signalling embarrassment in the blushing person. Blushing, as a feature of a larger state of affairs of which it signifies the remainder, is therefore a sign that is a signal. (This is not to deny that the external signs of emotion may be purposely simulated as by the professional actor, though in this latter case these signs would be symbols, not signals.)

All language signs are symbols (though not all symbol systems are "language"). But the physical embodiment of a language symbol may, in addition, have an expressive (hence signal) character. Said another way, language symbols sometimes have what might be called, for lack of a better phrase, a "signal side-effect." A common situation of the sort alluded to is one wherein a person reports something about his personal feelings, but in a way to cause dis-belief. For example, he might say "I am not afraid," but in a tremulous voice having features suggestive of fear. In a case such as this one, the same physical utterance has both a symbol (language) component, and a signal (expressive) component. Further, the two components signify contrary states of affairs: fear and not fear. Whenever the signal and symbol components of a single utterance are thus contradictory, it is the signal component that is taken as valid. This attests to what we all know when we stop to think about it: viz. that signal communication is indeed non-purposive, and therefore not under direct communicator control as is symbol communication. And, as an important and direct consequence of this fact, we all of us have learned, implicitly, to respond to signals as a more reliable variety of sign than are symbols.

3.4.3.1 Signification, denotation, and plurisituationality. By definition, all signs signify (sign-ify). But not all signs denote. To say that a sign "signifies," is simply to say that the sign directs behavior the way something else would, were it present to the senses. But to say that a sign "denotes" is to say, further, that the state of affairs signified does in fact exist. I might, for example, report that "I am not afraid." The verbal (or symbol) component of this utterance signifies to most speakers of English. But it denotes if, and only if, I am in fact unafraid. This distinction between signification and denotation is what lies behind the statement in the preceding paragraph, that signals tend to be more reliable than symbols.

To take another example: if I should step, bare-footed, on a prickly pear, and give a shout of pain that sounded something like "ouch," this might or might not be an instance of symbol communication. It would be symbol communication if I were not severely injured, and, being well in control of myself, wished to inform a listener of my plight by exclaiming "ouch!" in an emotional way in order to gain my listener's aid, sympathy or interest. As symbol communication, hence under voluntary control, I could exclaim "ouch" in all sorts of situations other than the one described, and thereby signify approximately the same state of affairs in each case. I could even do this when feeling no pain at all. In this last case, it would be said that my utterance signified, but did not denote.

If I stepped on a prickly pear and were so severely injured that I quite involuntarily issued a scream of pain, this would not be an instance of symbol communication, even if it should happen that my scream sounded much like "ouch." "Ouch," in this latter case, functions as a signal.

Signals are not detachable from their referents; rather, they are a part of the condition signified. For example, wet streets may or may not signal that it has rained, depending upon the nature of the larger situation of which wet streets are a part. Wet streets probably would not signal that it has rained if everything else in sight was bone dry. Similarly, sagging shoulders and a slowed gait may or may not signal the condition of tiredness: thus these body signs probably would not signal tiredness if the "sagging individual" were seen to be a hunchbacked cripple.

The distinction between signification and denotation was said to be related to the notion of "plurisituationality." A plurisituational sign is one that signifies in approximately the same manner in all situations (Morris, 1946). Plurisituationality is a necessary feature of signs that are symbols.

Again, consider the involuntary utterance of an ouch-like sound, made upon the occasion of stepping on a prickly pear. This behavior is very much like the speech-like expression of the gibbon. That is, it is an inseparable part of the feeling state, not the name for it. It is a symptom of a feeling (hence a signal), and is involuntarily evoked. Its significance therefore depends upon the nature of the situation wherein it was evoked, just as the ouch-like scream gained significance in the stepping-on-a-prickly-pear situation. But it is only when an utterance is plurisituational that it is symbolic. And it is only when an utterance has the potential for signification independent of denotation that it is symbolic (and also) plurisituational. In short, it is only when the possibility of prevarication exists that a sign becomes a symbol (see also, 4.3.1.2.5).

To say that a symbol is independent of the situation of its utterance for its meaning, is not to deny the importance of context in giving any utterance its precise meaning. Rather, it is to stress that unlike the expressive signal, one can, with symbols, speak of non-existent states of affairs: of hunger when satiated, of the sun at night, of next year today. The freedom from the immediate sensory environment made possible by symbols, is a capacity that makes it possible to think of reacting to the immediate sensory environment in a certain way, then adding something "in one's thoughts" and, thereby, deciding upon a different, possibly more prudent, course of action.[7] This important ability is frequently lost in certain types of brain-damaged patients as Goldstein and Scheerer (1941) have shown. Patients whose symbol functions are thus impaired, become suddenly and dramatically anchored to the sensory environment. (Goldstein and Scheerer describe a patient who could not be induced to repeat the sentence, "The sun is shining," on a rainy day; or to state that, "The snow is black.") In general, animals below man are highly determined in their behavior by the "here and now," while man, as Cherry (1957) has put it, is the "not here, not now," animal.

Since a signal is a part of a larger condition, of which it signifies the remainder, it might be argued that signals necessarily denote. I believe that it is generally true that they do, but there is a minor exception which should be noted. In the initial stages of a classical conditioning procedure, a buzzer (let us say) and the availability of food regularly go together. The buzzer is part of a larger situation (one that includes food), of which it signals the remainder. But after the animal has learned to respond to the buzzer as a signal for food, the food may no longer be available. Thus during extinction trials, the buzzer signifies but does not denote. When a signal ceases to denote, it gradually ceases to signify. Not so, the symbol. In a certain sense it may be said that some symbols never denote. Consider, for example, unicorns and centaurs.[8] Failure of denotation may have little or no effect on the signifying function of symbols.

single film carried two (at least connotatively) contradictory messages. Also, the U. S. citizenry was uncertain about Hitler at this point in time. Some saw the obvious benefits Hitler had so far brought to Germany, others saw a fanatical and dangerous dictator.

The "March of Times" film of this anecdote illustrates, in microcosm, the basis of an insidious difficulty underlying "media" research. What it suggests is that the units of analysis that have been used in research of the type described, are enormously gross; certainly too gross for the purposes intended. In following chapters I describe a hierarchy of units. I believe these can be instrumental in restoring order to a somewhat fractured realm of enquiry.

Note

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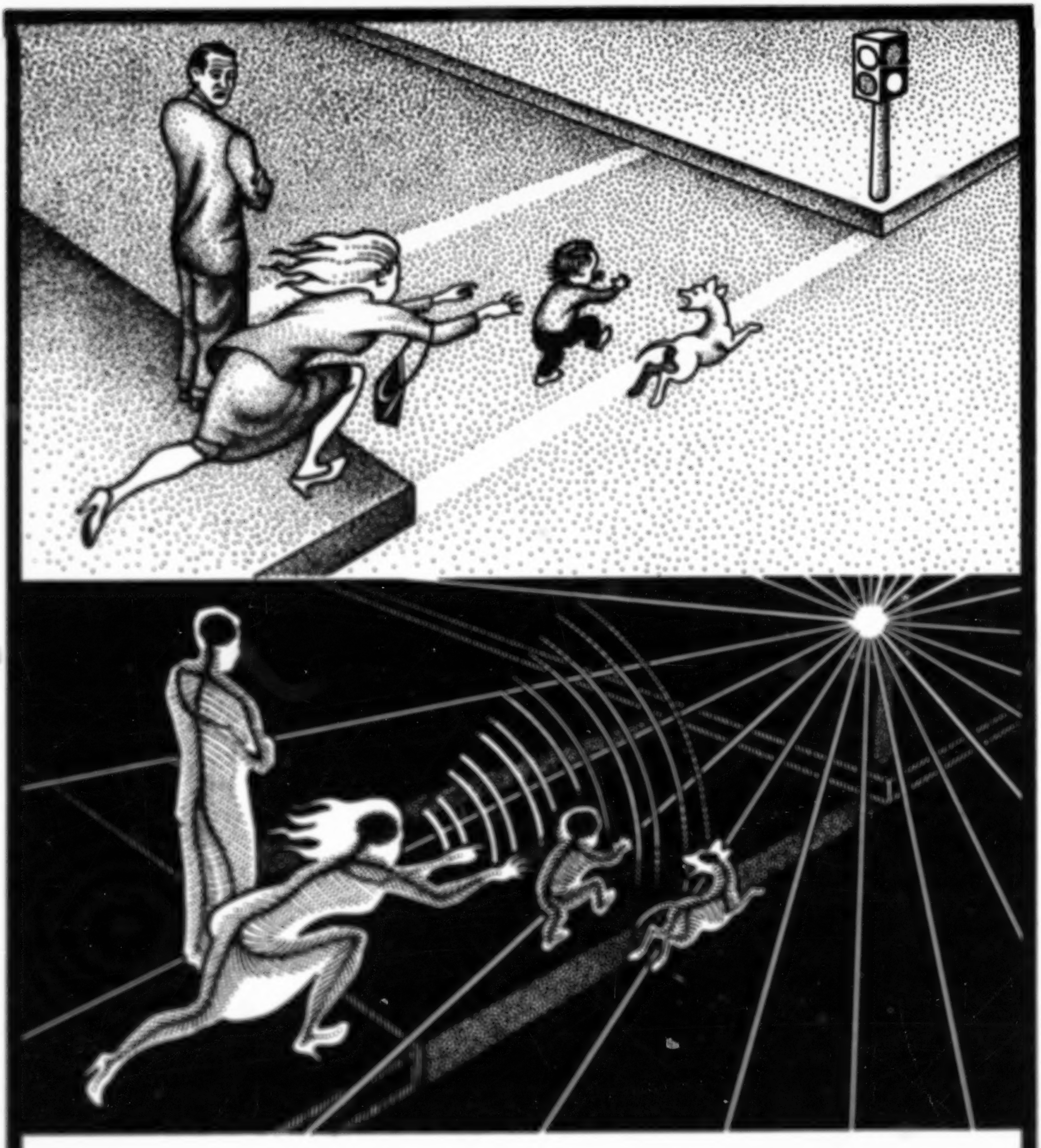


FIGURE 4.3 An illustration of the dependence of symbol-produced responses upon various contingent factors.

3.4.3.2 Summary comment. The central point of the foregoing can be briefly summarized using different words. This point is that a sign may substitute for another sign with which it is synonymous. Such a sign is a symbol.[9] Thus a symbol can take the place of a signal. For instance, one need not lead one's friend to the potato patch and point out the conditions of the vines, one can report this condition by speaking the name for it: that is, by producing a sign (the verbal utterance) that is a substitute for another sign (a certain condition of potato vines) with which it is synonymous.

In Figure 3.3, the stoplight depicted there is a sign that is a symbol for the man and woman in the illustration; though presumably not for the youth or his dog, who are crossing against it. It is unclear what the boy is attending to, but dog and woman both appear to be responding to the behavior of the boy. The dog, however, appears to be responding directly to the boy, while the woman is responding to the boy in a way determined by the symbol-status of the stoplight. The light stands for "stop," "danger," etc., including danger to a loved one; and although it would ordinarily keep the woman from entering the street, it effects an opposite outcome in the case illustrated. She dashes into the street in a wild attempt to retrieve the boy.

A traffic light has only an arbitrary connection with its referent. Once this symbol/referent connection is learned it "directs" behavior, but it does not "control" it in the immediate sort of fashion that seems to characterize the functioning of conditioned stimuli. The traffic light "stands for" stop, but not uncontingently. It stands for "stop" for the woman in the illustration at the very moment it evokes a response in her as different from "stopping" as can readily be imagined.

That which is involved in the signal/symbol distinction, seems to be a difference in degree of independence of conceptual processes: high independence in symbol behavior, less independence in signal behavior. Before an organism is able to employ symbols, it must be possible for the organism to handle the concepts in its conceptual repertory in such a way that each leads a relatively autonomous existence. Hebb and Thompson (1954) explain it this way.

> Two or more concepts must be capable of being aroused simultaneously, instead of one crowding the other out; and, as the term concept itself implies, they must be arousable by associative mechanisms in the absence of the sensory events that originally gave rise to them. That is, they are independent of any particular external environment, and of each other. Conceptual process A may be linked momentarily with conceptual process B at one time, with C or D at another. (p. 539)

Following this line of reasoning, Hebb and Thompson are lead to the following view.

> Let us propose as hypothesis the more general proposition, that the intellectual development in phylogenesis that eventually makes speech possible is an increasing independence of the conceptual activity from the present sensory environment, and an increasing capacity for entertaining diverse conceptual processes at the same time. (p. 539)

It is this that, among other things, makes it possible for man to build syntactical systems, and there would be no language as we know it, without such systems. (We continue with this point in Chapter Five.)

3.4.4 Sign and Sign Vehicle. Written words and their spoken counterparts differ physically even to the extent of involving different media--the visual and the auditory--and yet they typically evoke similar response dispositions in literate members of a speech community. Consider the written and spoken words, "hombre" and "man." Although these comprise four physically distinctive stimuli, they produce essentially the same response disposition in Spanish-English bilinguals. These four sign vehicles--the written and spoken versions of "man" and "hombre"--all make reference to a single concept.

In order, then, to be able to make the implied distinction, we shall say that the physically embodied word or picture (generally referred to as a "sign") is, rather, a sign vehicle; and that which shall here be called a sign is, rather, the disposition to respond that is regularly evoked by a sign vehicle (Morris, 1946). Thus the vehicles "hombre" and "man" in spoken and written form represent four instances of the same symbol category for a Spanish-English bilingual. If it were possible to create a stick figure that would arouse the concept "man" (and, generally, this is possible), such a stick figure would also be considered a member of this same sign (but not sign vehicle) category.

The term "sign" (or "symbol") will often be used to refer to both sign, qua sign, and to sign vehicle. To use an analogy of Ogden and Richards (1923), this is like saying, "The man mowed the lawn," when to speak more exactly, it would be necessary to say that the man pushed the lawn mower, and the lawn mower mowed the lawn. As long as the sign/sign vehicle distinction is in awareness, one can indiscriminately refer to both with a single word, and thereby rid one's exposition of some clumsiness. Whenever the distinction is critical, it will be spelled out.

3.4.4.1 On the independence of medium and message. The question arose in Chapter Two as to whether or not it would be possible to hold a message constant while varying the media. It was commented that whether or not this was possible depended upon one's criteria for determining "sameness" or "differences" in messages. We can now speak more precisely to this point, by employing the distinction between sign, and sign vehicle. Thus a change in medium would necessitate a change in the sign vehicles that were used. However, one might be able to change sign vehicles (say, from speech to writing) and keep the dispositions to respond reasonably constant. To translate from speech to writing or from writing to speech would be relatively easy; but there are other sorts of translations that seem much more difficult, even impossible, to make.

3.5 On Dispositions and Intentions

In foregoing sections I have employed two terms worthy of separate comment: "disposition" and "intention."[10] Intention (or purpose) refer to behavioral indicators of a sort suggested by the notion of "feedback": the communicator modifies his output in terms of the responses he produces in an interpreter. This requires that the observer be somehow able to infer the communicator's goals, and that he make repeated observations of communicator/interpreter interaction.

For example, bee communication as described by Von Frisch (1950) is non-intentional. Rather, it is reflexive, because a bee returning to the hive with information about the distance and direction of blossoms, dances its informative dance whether or not there are other bees already present and dancing, and it dances even when there are no bees present. A mother grouse, on the other hand, will attract the attention of a maurauder approaching too closely to her chicks, by flitting about as if her wing were broken. Her behavior can be seen, on repeated observations, to be governed closely by the results it produces in getting the maurauder away from where the chicks are hiding (Hebb & Thompson, 1954).

"Response disposition" also refers to states of affairs of a sort that are open to the public for inspection. For instance, the basis for assuming that different sign vehicles are members of the same sign category, is the fact that they direct behavior similarly. The "same" verbal request in written and spoken form will often evoke similar responses in literate persons; and a literate bilingual may respond quite similarly to a written request in language A and a spoken request in language B. Indeed, a monolingual observer who, by that fact, could not directly know what was going on, would, after observing such happenings on repeated occasions, say that the two kinds of messages "meant" the same thing. "Response disposition" seems an intuitively apt label to apply to this circumstance.

The importance of the sign/sign vehicle distinction can be seen by an inexact analogy with the distinction between learning and performance. "Learning" implies something about change, however described, in an internal state: something "inside the skin," hence non-public. "Performance" implies an externally observable state of affairs, open to the public. A problem (almost a paradox) arises, because many factors influence a learned performance besides learning--the organism may "know" what to do without doing it, or it may make a correct response fortuitously. Despite this treachery learning must be inferred from performance, for learning can never be measured directly. Moreover, because of unknown effects of fatigue, anxiety, etc., it is always possible that a reinforcing state of affairs could vary in a way that correlated with performance, though not with learning. What it is necessary to do, therefore, is make many sets of observations under many sets of circumstances; and most importantly, to never forget that performance is not a direct indicator of learning.

The sign/sign vehicle confusion must be avoided for roughly similar reasons. In recent years, though, psychologists have begun to employ sign vehicles as stimulus objects in experiments, sometimes thinking that, thereby, they were studying symbol behavior. Such efforts are often described as studies of "verbal learning." But as implied, this is inaccurate if the stimulus objects that are used (word, or other symbol vehicles) are used in a way that does not depend upon consideration of the generalizations (referents) named by the stimuli. In such a case as this, inferences about learning might sometimes be possible, but inferences about language-dependent, even language-related learning, are not. Words, as vehicles, could be equally as justifiably presented in mirror-image form, foreign-language form, or chicken-track form, with very little difference in results for many if not most non-language studies of "verbal" responses.

Notes to Chapter Three

1. The metalanguage developed here follows closely that of Bruner, Goodnow, and Austin (1956); especially as extended to language by Brown (1958). I owe these authors a special intellectual debt.

2. Some words, called "formators," are distinguished from others, called "lexicators" (Morris, 1946), on the basis that the former lack semantic status. Formators are words such as "or," "and," "not," "if," "then," and also punctuation marks. Such symbols do not refer directly to the non-symbol world, but to other symbols in an utterance of which they form a part. They indicate something about how these other symbols are to be interpreted. It would seem that formators do not name generalizations in the sense lexicators do, though they name highly generalizable rules. But whatever the case, I propose to side step this issue by reserving the term "word" for making reference to lexicators. When reference to formators is intended, the fact is made explicit.

3. The definition of sign followed in this monograph is based upon Morris (1946), and also Susanne Langer (1942). I follow Morris' terminology.

4. Morris' (1946) more accurate definition of sign, follows. "If A is a preparatory-stimulus that, in the absence of stimulus-objects initiating response-sequences of a certain behavior-family,

Notes to Chapter Three (Continued)

causes in some organism a disposition to respond by response-sequences of this behavior-family, then A is a sign. Anything that meets these conditions is a sign; it is left undecided whether there are signs that do not meet these conditions." (p. 354)

5. A "releaser" (ethology) is "a sign stimulus produced by the physical structure or behavior of an animal that releases some particular species-specific response or responses of another animal" (Verplanck, 1957, p. 27). "Innate releasing mechanism" is a phrase used by Lorenz (1951), who employs the analogy of "lock and key." The releaser stimulus is a "key" in the sense that it opens one particular door (releases a highly specific response). Lorenz seems to prefer the term "key" to that of "sign." "Sign," to this writer, seems inappropriate for characterizing a "releaser."

6. In Langer's (1942) terminology, that which is here called "signal" is labelled "sign." She uses the term "symbol," as here. Langer thus lacks a generic term such as found in the present use of "sign," to refer to both signals and symbols.

7. Hebb and Thompson (1954) make the point developed here. These authors have greatly influenced this writer's thinking along the line explored in this section.

Notes to Chapter Three (Continued)

8. This is ambiguous. "Unicorn" might signify "strange but existent animal" to one interpreter, and "mythical creature" to another. I speak too simply on this point; but it is a subtle point and, for present purposes, one unworthy of a digressive explanation.

9. Morris (1946) defines "symbol" as follows: "A sign that is produced by its interpreter and that acts as a substitute for some other sign with which it is synonymous; all signs not symbols are signals." (p. 355)

10. In the "language of science," "disposition" and "intention" are terms that fall at an intermediate position between "data language" and "theoretical language." That is, they label classes of data statements. As such, they must be operationally definable. "Reinforcement" is a fairly common term that falls at the same "level" as do "disposition" and "intention." Verplanck (1957) discusses this matter in the preface to his monograph, A Glossary of Some Terms Used in the Objective Science of Behavior.

1.0 WORDS AND PICTURES

> The trick of naming relations instead of illustrating them gives language a tremendous scope; one word can thus take care of a situation that would require a whole sheet of drawings to depict it.
>
> -- Susanne Langer

> The "elements" that the camera represents are not the "elements" that language represents. They are a thousand times more numerous. For this reason the correspondence between a word-picture and a visible object can never be as close as that between the object and the photograph.
>
> --Susanne Langer

The present and following chapters are about "words" and "pictures." The relative stress varies as between these realms in a way that depends more upon the particular topic being considered, than upon the particular chapter. The present chapter is concerned with language in general, and with similarities and differences between language and pictorial modes of communication. The following chapter focuses on concept attainment, especially in young children.

1.1 What is an Iconic Sign?

Iconic sign has been distinguished from digital sign in a preliminary fashion. The concept is central, though, and an attempt to describe it in a more detailed fashion is indicated. Definition in the case of iconic sign involves a consideration of some factors whose importance has not typically been recognized.

4.1.1 Typical Definitions. An iconic sign is usually defined as one that resembles that for which it stands. Drawings, paintings, photographs, statues, maps, graphs, and such, are examples. A digital sign, on the other hand, is said to bear no resemblance to its referent. It is arbitrary. Words, numbers, flag signals, the sign language of the deaf, etc., are examples. In the digital realm all, or nearly all, "non-word" codes are only superficially non-word: They are, in fact, based directly on words. We shall see, moreover, that this state of affairs applies as well in the iconic realm. That is, iconic "codes" are also based upon (or depend upon) words.

A word bears no resemblance to its referent.[1] Its form is arbitrary. A picture, of course, is not totally arbitrary, but it does involve a good deal of conventionalization in its production, and learning is involved in its interpretation. However the learning that is involved is often rapid and readily "generalized."[2] In this paper, a sign will not be called arbitrary unless it is totally so. By definition, then, digital signs are arbitrary, iconic signs are not (because never totally so).

Morris states that "A sign is iconic to the extent to which it itself has the properties of its denotata; otherwise non-iconic" (1946, p. 349). Said another way, the greater the number of attributes shared by sign and referent, the higher the degree of iconicity. However, this is incomplete, for it ignores attribute criteriality. It also ignores the interpreter of the sign.

To illustrate the first difficulty, consider that the highest degree of similarity between two things is identity. While no single sign vehicle could be identical with a referent *category*, a single sign vehicle could be made to approach identity with a single member of a referent category. Thus one could, as in cue-reduction problems, begin with a single member of a referent category (some single object, perhaps) and then abstract out and discard various attributes of this object until the point was reached where the remainder was no longer remindful of the object with which one began. The problem is to determine which attributes are noncriterial for recognition, and so to be discarded; which are of low criteriality and to be discarded at the cost of some impairment of recognition; which attributes must be retained if recognition is not to be lost.

Thus if one had an *egg*, one might remove the attribute of shape or form by scrambling the egg, or by setting it under a chicken and hatching it; but the result in such a case would not be remindful of "egg" but of "scrambled egg," or "baby chick." On the other hand, one could remove the attributes of 3-dimensionality, color, and size by photographing the egg and enlarging (reducing) the picture until it was, say, one-and-one half times egg-size, and still have a remainder that was a reminder of "egg," as such. The criteriality of attributes, then, and not their number, is the thing of importance.

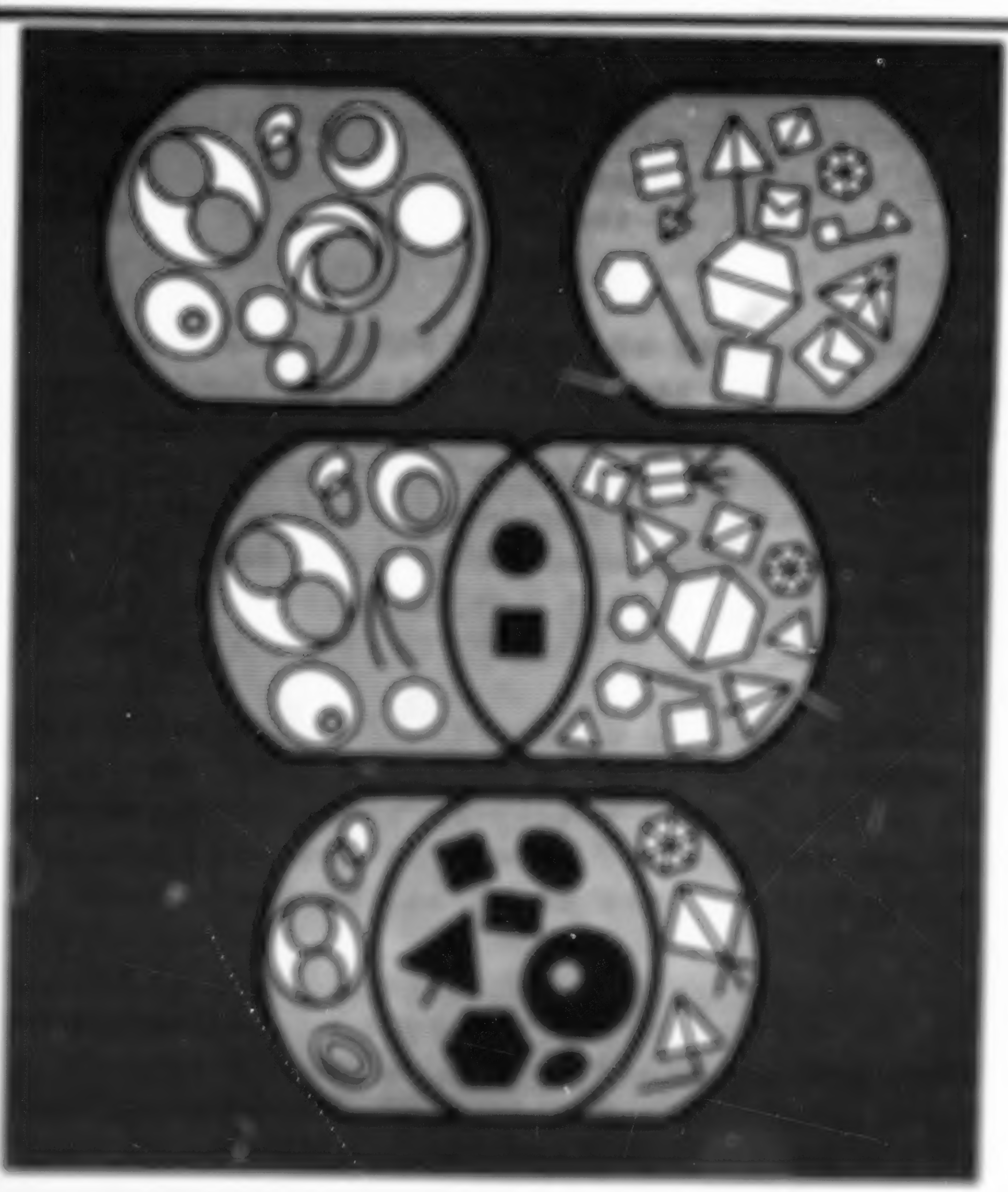
Gibson (1954), in an article recording his thoughts on pictures, perception and communication, wondered how one might conceptualize the degree of fidelity that existed between a picture and its object. His aim, however, was in keeping with the communication context he assigned himself, and he spoke of iconic surrogates. He concluded that the most faithful picture (presumably the one highest in iconicity), is one that reflects a sheaf of light rays identical to that which would be reflected from the object photographed.

Gibson's answer seems acceptable within a perception orientation. But a difficulty arises when the question becomes, as in a communication context: How is an iconic sign (or surrogate) like its referent *category*? In his attempt to extend a perceptual notion to the communication area, Gibson limited himself to the very special case of the single instance of an identity category. From a communication point of view, this represents a highly limited class of cases.

Is it possible, though, that iconic signs are limited in precisely this way? Is it possible, in other words, that there are no iconic signs at all? (See 1.2.1.)

1.1.2. Definition in Terms of Shared Conceptual Repertories. I propose to retain the term, "iconic sign," and I would define this term in a way to highlight two facts. First, the iconicity of a sign is dependent upon the existence of criterial attributes

Sign Category | **Referent Sign Category** | **Nature of Relationship**



- Arbitrary non-representational; no sharing of criterial attributes. Connection is by association. ("Words" are an example.)

- Not entirely arbitrary. Sign and referent share criterial attributes. Connection may be facilitated by learning, but by "easy" relatively rapid learning (as, e.g., in learning to read pictures).

- Sign and referent are confused. The only attributes not held in common are non-criterial or of low or only potential criteriality.

FIGURE 4,4 An illustration of the author's definition of a pictorial (or other representational) sign. The TV-shaped ovals represent categories. These contain small geometric designs representing attributes of the enclosing category--rounded for sign categories, and angular for referent categories. In areas of overlap between sign and referent pairs, shared criterial attributes are both rounded and angular, and also "filled" in.

common to sign vehicle and referent category. Second, the degree of criteriality is different for different persons. Thus of all the potentially criterial attributes that might be shared by sign and referent, only a part might be used by the producer of a sign, and only a part of this part, by the interpreter of it.

I would therefore say that a sign is iconic to an extent dependent upon the number of attributes having actual criteriality for both the producer and interpreter of the sign in the task of (a), determining the sign vehicle's membership in a sign category, and (b), the membership of a "thing" in the sign's (presumed) referent category.[3] This lends itself to a spatial analogy as shown in Figure 4.1.

Two features of this definition invite comment. First, while it is apparent that one's concern be directed to shared attributes, it is not entirely apparent as to what is the immediate gain that comes from this recognition. One is faced with the problem of determining the classes of attributes (if any) that have a high potential for criteriality in forming both sign and referent categories. It seems clear that there is at least one such category in the visual-iconic realm (and probably the tactual-iconic as well). It would seem that a visual-iconic sign must bear an analogy of form or configuration with a "good exemplar" of the referent category. There must be an isomorphism of visual contours (or of tactual contours in the tactual-iconic sphere) between sign-vehicle and referent exemplar. This, of course, has often been suggested.[4] It is a question, though, as to how sufficient this description is. Are other "types" of "isomorphism" important? And, too, there is the problem of specifying the criteria for distinguishing "good exemplars."

The second point has to do with the requirement that the shared criterial attributes--those shared by sign vehicle and referent--be also shared in the sense of having actual (not merely potential) criteriality for both the producer and the interpreter of the sign. This is to say that iconic signs, far from signifying universally, must be recognized as being post-conceptual signs (4.2).

4.1.2.1 Non-sign icons. All sign processes are (at least)[5] three-part in nature. These three parts are the organism, the sign, and the referent. If sign and referent are confounded, (in the sense that the potential sign vehicle is the thing of interest), the process is two-part, and the potential vehicle remains only potential: that is, it is not a sign. Thus pictures frequently have an interest in their own right; for example, as aesthetic objects. Such pictures function quite differently than (say) the instructional photos in an automobile repair manual, where the picture directs one's behavior relative to the parts and functions of actual automobiles. In what follows, reference will always be to pictures as signs--more particularly, as symbols--and as used in inter-personal communication.

4.2 The Post-Conceptual Status of Iconic Symbols

Success in pictorial communication requires that the symbols that are used have "post-linguistic status." The argument will be put forth that iconic symbols are necessarily post-conceptual, and that a non-necessary but highly probable consequence of this, is that iconic symbols are post-linguistic, as well.

To say a symbol is "post conceptual," is to say that the fact of its ability to signify a concept is dependent upon that concept having already been attained by the interpreter of the symbol. Thus put, this idea is trite; for, indeed, it is true by definition. Despite this, the fact of the post-conceptual status of iconic symbols seems regularly to have escaped notice in several sorts of situations where the relevancy of this fact should be demanding. If I belabor the obvious in the following paragraphs, then, it is because in some contexts the "obvious" seems not to have been so obvious after all. We begin with three related examples.

First, consider a situation wherein the concept of interest has yet to be invented. For example, assume Mars has Martians with sensory equipment like our own, and that Mars has no gravitational field. Martians, therefore, would have had no need to have invented furniture hence no need for the concept, "furniture." (A Martian in a gravity-free environment would require no furniture because his dishes and clothes and he himself would remain wherever placed until again moved.) An earthman just landed and ready to teach the Martian about the earth, might use pictures. Pictures would serve well for some purposes, but not for communicating the concept "furniture," or the sub-categories thereof. Pictures of tables and chairs and actual tables and chairs would all be exactly as meaningless as would visual displays of the letters of the earthman's alphabet.

Let us next hold concern for a concept already existent in the minds of many of our contemporaries: for example, the concept of "mammal." Pictures of a whale, a goat, an aardvark and a man, presented in an "adequate" contextual frame, might arouse the concept, mammal, in an interpreter independently of words. For this to be the case, it would of course be necessary that the interpreter had already attained that concept. If he had not, as would usually be the case with a young child, no number of pictures of mammals could, by themselves, arouse this concept; nor would a trip to all the zoos of the world much help matters, if this were un-accompanied by discursive explanation.

Let us imagine, finally, a case wherein communicator and interpreter similarly classify and label many (though not all) instances of a concept. In such a case as this, the circumstantial evidence may indicate that communicator and interpreter share a common concept. If so, such a concept should be arousable by the appropriate selection of iconic symbol vehicles. But this may be an incorrect interpretation, as the following example shows.

Imagine that a 35-year-old mother and her 4-year-old daughter independently catalog the household appliances in their neighborhood according to their common names. It would be no surprise if mother and daughter should agree much of the time. For instance, they might agree perfectly in separating kitchen stoves from not-kitchen stoves. If so, most observers would assume that mother and daughter had employed the same set of criterial attributes in forming the kitchen-stove category, and that both possessed the _same_ (kitchen stove) concept.

But what can validly be intended by the term "same" in this example? It is precisely to the clarification of this point that further analysis is required.

Very young children (about 19 months) can correctly label a clear picture of an object, once they have learned to correctly label the object (Hochberg & Brooks, 1962). It is on this basis that picture vocabulary tests seem sometimes to work fairly well with preschoolers. Thus in the 1937 Stanford-Binet, there is a test item for four-year-olds which contains, among other things, schematized pictures of a kitchen stove and a bird. Today's 4-year-old would be likely to recognize the bird, but not the stove. The stove is an old-fashioned coal-burning stove that has not been around for quite a few years now. Thus, although the 4-year-old of the example would generally be thought to have attained the concept stove, the test result would indicate that she had not.

And although both mother and daughter would ordinarily be thought to possess the same kitchen stove concept, this example makes it obvious that they do not share exactly the same concept. Furthermore, the difference in the illustrative example is great enough that some care would have to be taken in the choice of an iconic symbol vehicle to represent this concept if one were to have confidence that the chosen vehicle would signify for the child.

We have been saying, by means of these examples, that before an iconic symbol will be similarly interpreted, the conceptual repertories of those involved in the communicative act must include the relevant concepts, and that these must be (fairly nearly) the same.

4.2.1 That There Are No Iconic Symbols. Bierman (1962) defends the thesis (which he uses as the title of his article), "that there are no iconic signs." To this thesis he adds one critical qualification: "There are no signs whose denotation and signification depend solely on their resemblance to that which they denote" (p. 245, my emphasis). I believe this position has merit--indeed, that Bierman has a valid argument--if (as implied, to be iconic) a sign's denotation and signification must depend solely upon the sign's resemblance to its referent. But if icons depend upon prior mastery of the concept signified by the icon--which is the argument developed in the preceding paragraphs--then the icon, if schematized and thereby made barren of detail,[6] can evoke the verbal name of the

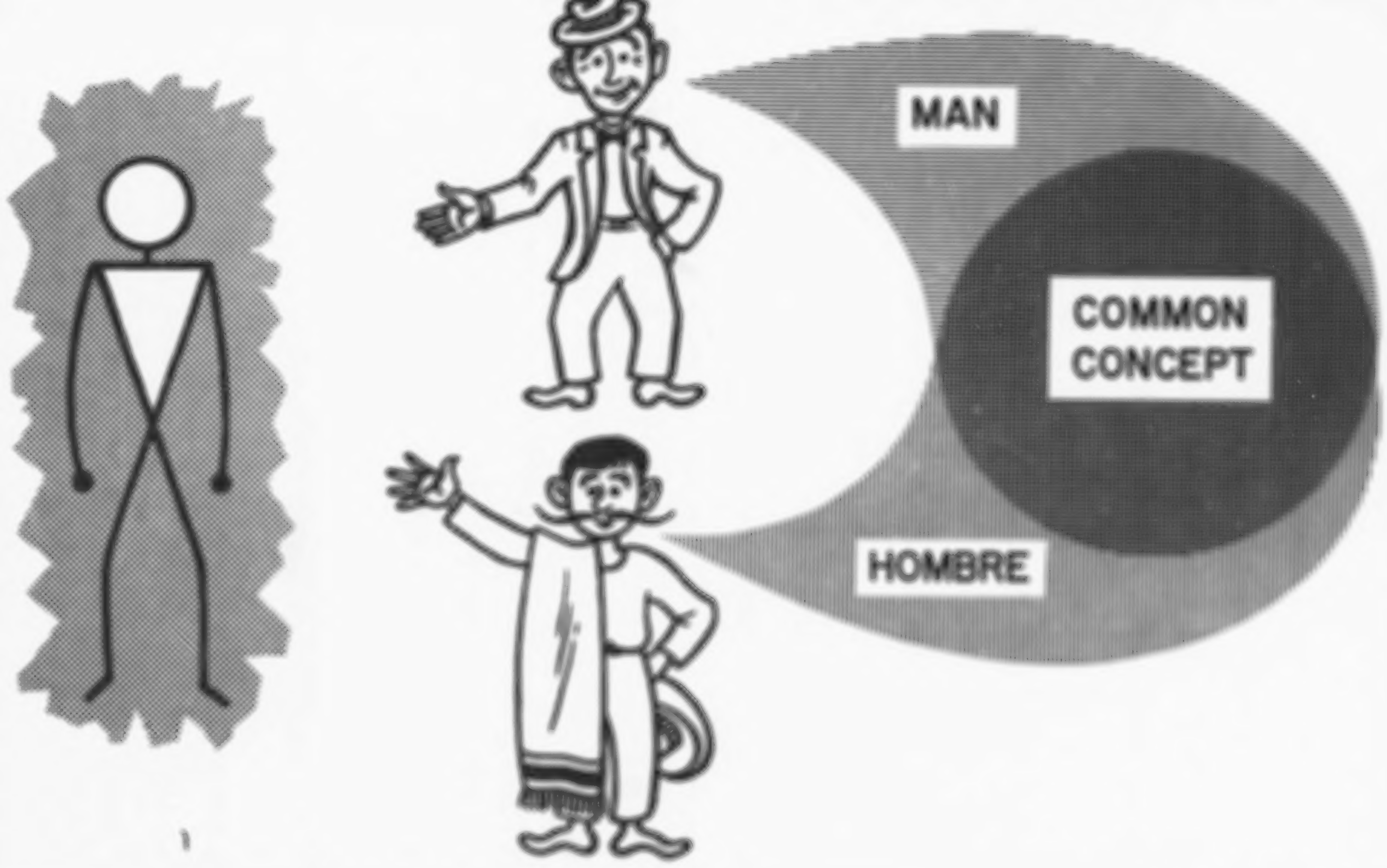


FIGURE 6.4 A schematized pictorial symbol with "post-linguistic" status can signify an equivalence category, even across language boundaries. Pictorials cannot be assumed to signify equivalence categories if they lack "post-linguistic" status.

concept, thence the concept, qua concept. Thus I would argue that there _are_[7] iconic signs, but that this fact depends directly on an icon having post-linguistic status. This is illustrated in Figure 4.2 in a way to suggest an important use of iconic signs in communicating across language boundaries.

4.2.3.1 That post-conceptuality implies post-linguisticity. If a symbol is post conceptual, the likelihood is great that it is post linguistic as well. Concept formation in man is highly dependent upon verbal processes, and there is every reason to believe that non-verbal animals (including the occasional non-verbal man) have greatly impoverished conceptual repertories. But granting that concepts do get established non-linguistically—which they sometimes surely do—it is still true that this fact must generally be ascertained linguistically. Considering the case only of inter-personal communication (ignoring, for the moment, the case where one communicates with oneself), it becomes quite clear that success in pictorial communication depends upon the signs employed having post-linguistic status for their users.

4.3 Picturing the Unpicturable

The tautology that one cannot picture the unpicturable, is, perhaps, only logically true. Psychologically (and in a certain sense described later), it may be that one can indeed "picture" the unpicturable. We begin with the logical case.

Some conceptual categories have no picturable elements (e.g. "truth," "gravity"). It will not be claimed that these can be represented iconically in any sense of that term. But it is equally as impossible *directly*, non-metaphorically, to picture a concept in the case where the members of the conceptual category could easily be pictured if taken individually (e.g. "triangle," "dog").

1.3.1 Realistic Pictures Say Too Much. Partly, this is because detailed, realistic pictures say too much: that is, in the sense that many of the attributes of a picture are noisy for the task of signifying some particular concept. The concept "triangle" as defined in Webster's Collegiate Dictionary (as "a figure . . . formed by three lines intersecting by twos in three points, and so forming three angles . . ."), sets forth the criterial attributes of a category having an infinite number of members. And logically, if not psychologically, a picture of a right triangle is equally as valid and equally as invalid an exemplar of the concept triangle, as is a triangle with one angle of magnitude 179 degrees.

A realistic picture of a juicy mouth-watering steak carries an immense amount of information about at least one such steak. These numberless details are attributes. Any given attribute may be criterial relative to one categorizing purpose and, at once, noncriterial relative to a second purpose. Degree of lusciousness defined by certain qualities of color, form and texture, involves attributes that are criterial for separating steaks one wishes to eat himself, from steaks one would give to his pet dog, from yet other steaks (e.g. rotted, maggot-ridden steaks) that are to be disposed of. But these same attributes would be noncriterial if the task were to illustrate proper and improper ways to cut steaks.

Often times, an interpreter would regard various of the attributes of the steak as criterial, others as noncriterial, depending upon factors that could not be foreseen by a communicator. If the interpreter were provided no strong context clues such as might be provided by a series of pictures, nor verbal indicators, nor some pre-potent set, it might not be possible to determine which of the attributes of a picture he would attend to, and which he would ignore.

4.3.2 Pictures Give Knowledge Of the World. What was just said with reference to realistic pictures, applies as well to perception of the real world. Thus a novice would not be expected to learn very much about jet engines simply by observing one in operation. The whole business is too complex. There is much too much to attend to.

But when a visual display is demanded, and when the feature of the world that is of interest is so complex that it is uninterpretable, pictures may be able to present what is most important, if schematization is used (see 4.3.3). It is hard to imagine, for example, how one could digitally supplant a visually animated schematization of an operating jet engine, if one wished to give knowledge of jet engines. In such a case as this, an animated filmed presentation

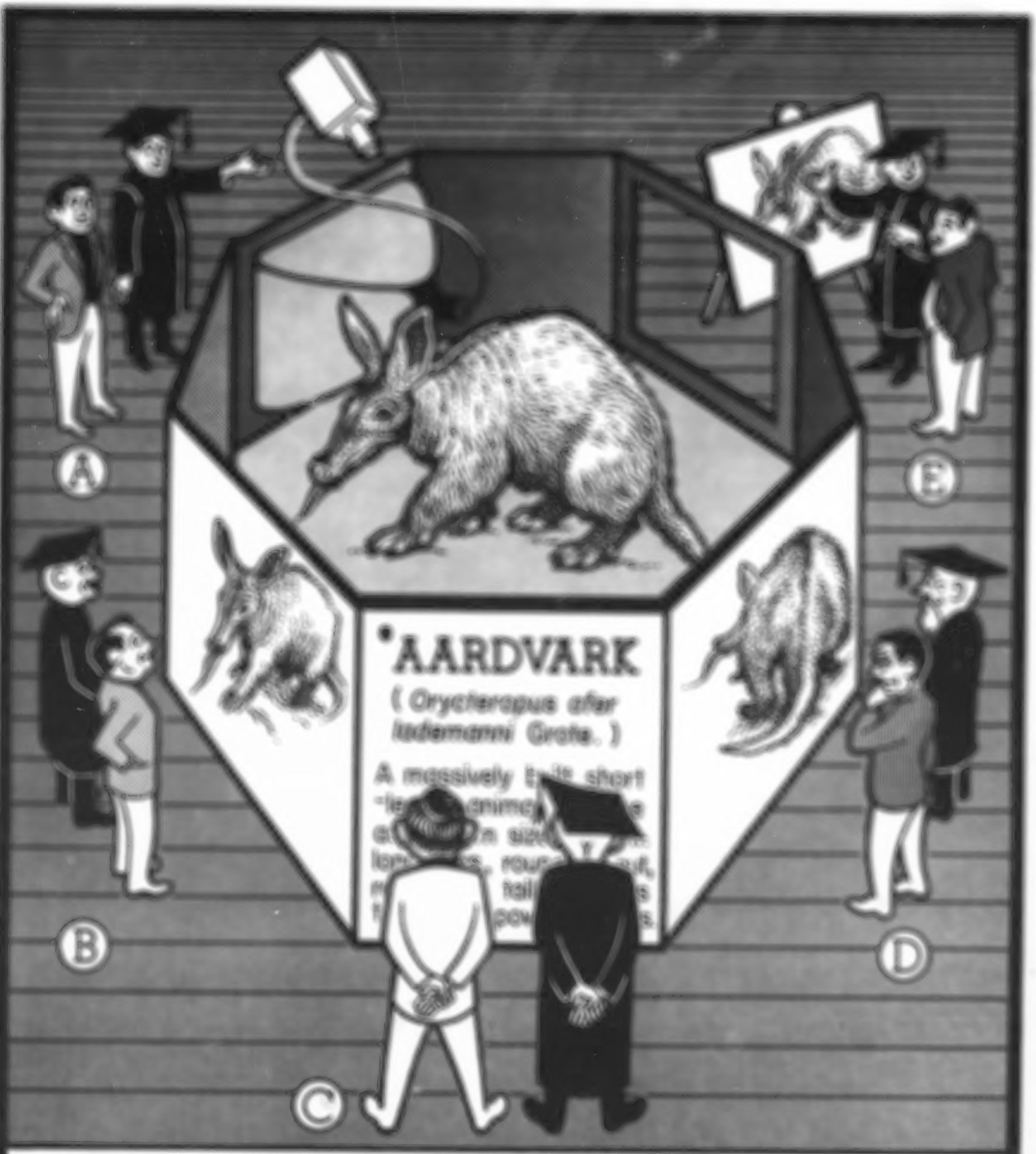


FIGURE 6.5 An illustration of the difference between knowledge *of* ("perceptual information") and knowledge *about* ("conceptual information").

would be supreme.

This reference to "knowledge of" (jet engines) is, I think the key phrase suggesting one important source of error occasionally found in the writings of students of pictures. It is a confusion whose source lies in sometimes failing to distinguish between knowledge _of_ something, and knowledge _about_ it.[8] The following discussion of this difficulty is based upon Knowlton (1964, pp. 32-37).

Pictorial symbols are useful for giving knowledge _of_ the world: verbal symbols for giving knowledge _about_ it. Knowledge _of_ things refers to the immediate sensory "givens" whereby one has immediate acquaintance with the perceptible world. Knowledge _about_ something refers to conceptual knowledge.

The confusion between these that sometimes results has a classical illustration: viz., the often cited "experiment" conducted by the advertising department of _Parade_ magazine. In this informal exercise, a trio of artists ignorant of aardvarks was asked to draw this animal from a brief verbal description of it. Their failure to agree with one another in their drawings; or for any one of them to produce a drawing similar to an authentic pictorial rendering, was taken as a result supportive of an uncontingent argument for the supremacy of pictures and the inadequacy of words. (See Figure 4.3 for a verbal/pictorial interpretation of this position.)

This outcome does support the use of pictures to convey knowledge _of_ something: in the present example, knowledge of aardvarks; in the earlier example, knowledge of jet engines. However, it does not support the idea that pictures are useful for conveying knowledge *about* aardvarks or jet engines. Pictures cannot directly convey knowledge to the effect that an aardvark is a mammal, hence warm blooded and viviparous, and thus an animal that is more closely related to the whale than the ostrich. (A picture can portray mammae, for example, but this portrayal is a portrayal of just that- mammae. The further inference that the presence of mammary glands implies "mammalness," depends upon the prior establishment of that concept by discursive means.) Nor can pictures reveal that an inflated toy balloon, let loose with the air escaping through the neck, is fundamentally similar to a jet plane, and that a cork screw is more similar to a prop-driven plane. Of course the information that the aardvark is a warm-blooded, viviparous relative of the whale would not help one draw a picture of either a whale or an aardvark. But then a picture of "mammalness," if there could be such a thing, would have to be representative not only of certain characteristics of whales and aardvarks, but also o' donkeys, men, swine, etc.

1.3.3 That Pictures CAN "Represent" Concepts. We have been saying that it is not possible to represent a concept iconically. But it may be possible to *suggest* a concept with an iconic symbol if the concept has been attained, and if the iconic symbol is a "good" exemplar of the concept. Werner and Kaplan (1963), p. 15) use the phrase "exemplificatory representation" to describe such a possibility. This seems an apt phrase because, strictly speaking, the concept is not represented, but exemplified: it is exemplified by a concrete object (or its picture) that has membership in the conceptual category of interest. Of course everything hinges upon the adequacy of the exemplar; and here, as previously, we have spoken of the "good exemplar" to imply this fact, though without saying much about the requirements for such a category member. We can only begin to get at this problem here: a problem which, in any case, is largely empirical. We attempt this beginning after first clarifying a common confusion concerning a favorite notion of the student of pictures:[9] the notion of an "abstract/concrete dimension."

The phrase "abstract/concrete dimension," though it implies a single continuum, has often been indiscriminately used to label two distinctively different continua. One use applies validly to symbol categories. "abstract/concrete dimension" denotes the degree of iconicity or lifelikeness of the symbol. When applied to referent categories, it denotes the degree of superordination/subordination of those categories.

These two meanings for abstractness/concreteness correlate, though not perfectly. They therefore must be kept separate. The designation "abstract/concrete" will hereafter be used exclusively to refer to the degree of superordination/subordination of referent categories, while "degree of iconicity," or "degree of lifelikeness" will be used to describe symbol categories.

Symbols high in iconicity will generally signify only concrete (subordinate) referent categories. Indeed, detailed photographs can generally signify only identity categories. On the other hand, single language symbols[10] (except proper names) signify relatively abstract (superordinate) categories. (However, the range of subordination/superordination that can be signified by a single verbal symbol is wide, thus: salmon, fish, animal, thing).[11] This, then, is the basis for the noted correlation between degree of iconicity of signs, and degree of abstractness of the associated referent categories.

The correlation is, however, imperfect. To illustrate: A photograph of a person, say of Sam Smith, would not ordinarily signify the concept "man." If this photograph were made barren of detail to the point where a stick figure emerged, this barren icon might signify "man" for most interpreters. Thus a barren icon (stick figure of "man"), and a single word, "man," might signify very nearly identical referent categories. If so, there exists a case where signs vary in iconicity while that which they signify remains constant as regards degree of abstractness.

A clear photograph of a particular person would ordinarily be taken as a highly iconic symbol vis-a-vis that particular person; but if this same photograph were made to signify the broader concept

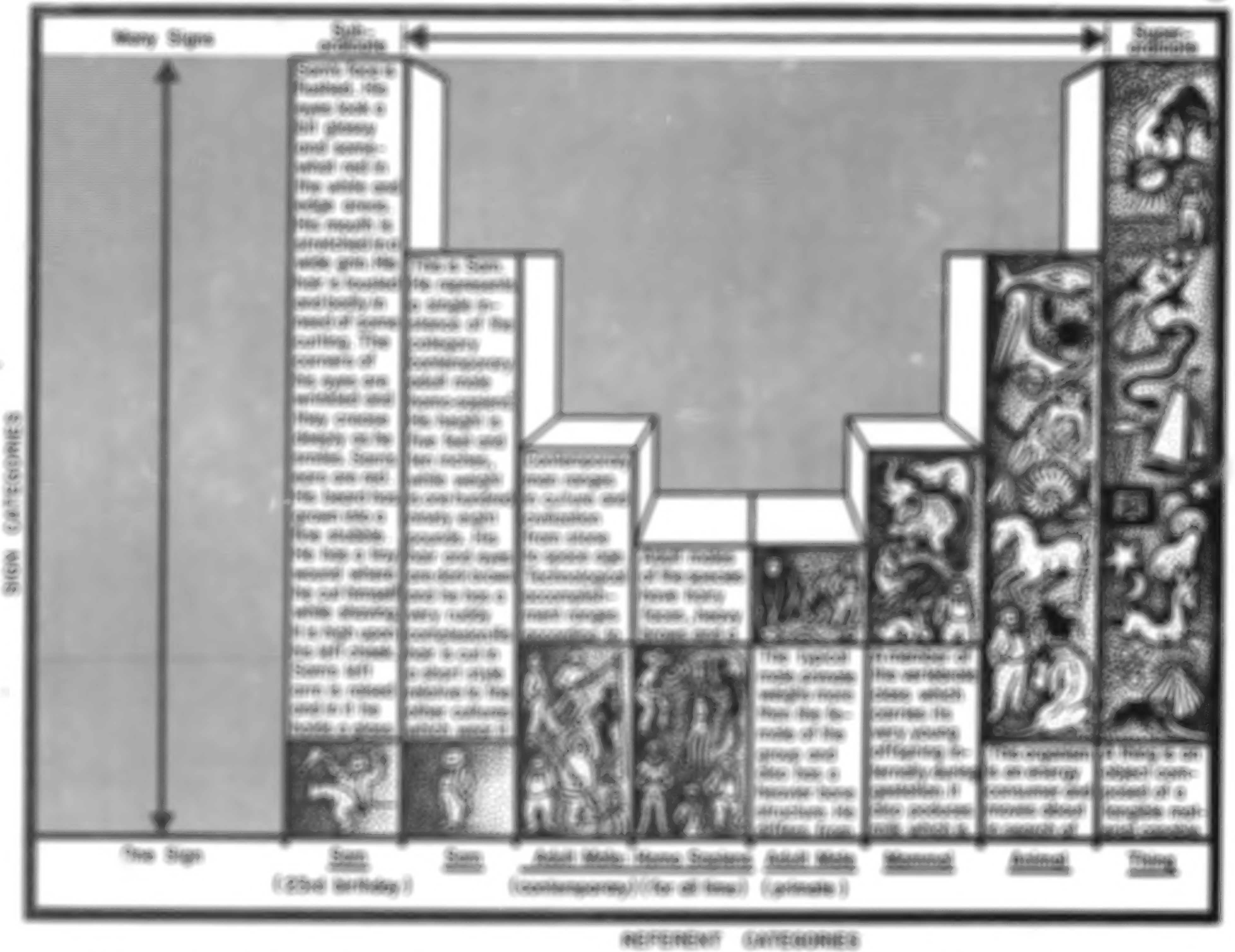


FIGURE 6.2 The number of signs required to call subordinate and superordinate referent categories to mind as this depends upon the use of digital signs on the one hand, and iconic signs on the other hand.

"man" by the appropriate manipulation of context, set, etc., the identical symbol vehicle would thereby become less iconic. This follows from the definition of an iconic symbol as one sharing criterial attributes with the referent category. If one follows such a definition, the iconicity of a symbol vehicle can be said to change either as a result of changes in the physical characteristics of the vehicle, or as a result of the manipulation of context, set, etc. in order, thereby, to change what is signified.

In Figure 1.1, the horizontal axis depicts a subordination/superordination continuum. That is to say, reference is to referent categories. The left (subordinate) end of this continuum is illustrated by the instance "Sam Smith celebrating his 33rd birthday." This represents a single instance of an identity category: the "Sam Smith" identity category. Another instance of the "Sam Smith" identity category is illustrated by the second column to the right. Thereafter, in terms of increasing degree of superordination, are the equivalence categories: "contemporary adult male, homo sapiens"; "adult male, homo sapiens"; "adult male, primate"; "mammal"; "animal"; "thing."

The heights of the vertical columns in Figure 1.1 represent the number of symbols (either verbal or pictorial) presumed to be necessary in order to signify the several referent categories represented along the horizontal axis. To signify 33-year-old Sam with a picture, for example, is easily accomplished. A single photograph would do. This is represented by the height of the pictorial portion of the left-hand vertical column. To describe 23-year-old Sam in the detail made possible by a picture, but with words, would be well-nigh impossible. It would take thousands of carefully chosen words even to approximate the description possible with a single picture. This, then, represents the case where "one picture is worth ten thousand words" (except, of course, that this old saw presents a gross understatement in the present case).

In the right-hand column, on the other hand, is illustrated the case where one word is worth many thousands of pictures. To signify the concept "thing" using only pictures would be difficult. It would be difficult to thus signify "animal." To do this latter, numerous pictures of fleas, fish, birds, reptiles, etc. would have to be presented contrastively with rocks, plants, planets, etc. The interpreter would have to induce the generalization; though, in having previously attained the concept, he might be able to guess it after only a few pictorials had been presented. These would have to be pictorials that were carefully selected, though, so as to achieve a highly variant sample of category members (i.e., of animals). The strategy would be to select pictures in a way best to exploit the kind of logic one employs in correctly playing the game of Twenty Questions.

To summarize: Iconic symbols may be useful in signifying identity categories if considerable detail is desired. Digital symbols would be used to signify equivalence categories. But a problem might be involved if one wished to use words to signify a specific feeling or to convey the many details of a single instance of an identity category. This would require the skill of a great literary talent. However, the student of pictures is likely to be more challenged by a fourth case: the case wherein one is especially desirous of using iconic symbols to make (relatively) abstract reference. This problem arises whenever there is a need to teach fairly abstract concepts to illiterates, or when there is a need to communicate across language boundaries. In such a situation as this, one could not depend chiefly upon highly iconic symbols. To do so would too often be to signify too narrowly. On the other hand, if one's symbols were schematized too highly, the very gain sought would be lost because iconicity would be lost. The task is to find how barren an iconic symbol can be made without losing its one important quality: that of suggesting its referent without there being a need for a translating key. The linguistic histories of the interpreters involved set obvious limits to what can be done along this line.

4.4 Language

Knowledge of how iconic symbols function depends upon an understanding of the important contrasts between iconic and speech symbols. The reasons for this are the usual ones stated for the comparative approach, and they are the reasons for the present interest in language. The present section is primarily a discussion of language, then; while in the following section (4.5), we shall compare language symbols (or words) with pictures.

It is usual to regard speaking and writing as instances of language. This is a generally acceptable confusion, but it will be useful here to make some finer distinctions that will separate language, not only from speech and writing, but from other language-related performances aswell.

4.4.1 Speaking is not Language. Neither speech nor writing are language. However, speech is closely linked to language, for language is inferred from speech. The basis upon which speech may be distinguished from language is this: that persons lacking all speech may, nevertheless, understand it; while, on the other hand, there are persons who can "speak" but do not understand speech.

Lenneberg (1962) presents a case history that illustrates the first point. He describes the case of an eight-year-old boy who has never had the ability to speak, but who clearly showed that he understood speech. This child could follow tape-recorded instructions, and he could do this in isolation from any human agency who might give unintentional gestural cues were he in the child's presence. This child could follow instructions to do such things as, "Take the block and put it on the bottle." The question that arises, is whether or not it is reasonable to say that this child who lacked the ability to produce speech (but understood it), also lacked language.

The second point is illustrated by the pathological phenomenon known as echolalia: "the involuntary and senseless repetition of a word or sentence just spoken by another person" (English & English, 1958). The normal infant's first word-like sounds are also without meaning as are the "utterances" of "talking" birds such as the parrot, jackdaw, cockatoo. In all these instances there is mimicry without understanding. Certinly it would be a strained interpretation to say that the child described by Lenneberg was without language, while the sounds produced by young infants, by "talking" birds, or by the echolaic adult, on the other hand, were indicative of language.

As the above paragraphs imply, language is not directly observable. The existence of language has to be inferred, as does the existence of any learned behavior. In the case of language, speech is the externally observable behavior that is the index generally used in terms of which to infer language. In these matters, the study of language is perfectly analogous to the more general study of learning. Just as the student of learning must carefully distinguish between performance, and the unobservable hypothetical construction labeled "learning" which is perdicated in order to better account for performance, so, too, must the student of language carefully distinguish between speech and language: between a verbal performance and the hypothetical construction labeled "language" which is predicated to account for it.

4.4.2 Writing is not Language. Speech is not language, nor is writing. But writing is less closely related to language than is speech; indeed, writing is a phenomenon that in several important respects is closer to "picturing" than it is to either speech or language. This is because pictures that function as symbols are necessarily post-conceptual symbols (as see 4.2), and it is highly probable, therefore, that they are post-linguistic symbols, as well. Both writing and picturing thus depend upon language. And, in this sense, both writing and (at least symbol) picturing are more accurately described as means for encoding speech than as a means for encoding "the world." Finally, both writing and picturing (though not speech) require tools for their production; and so man, or near man, must have been a technological creature before he could have developed either writing or picturing abilities (though not speech).

All human societies have language, and no language is primitive.[12] Sapir (1921) early asserted this--that the technologically most backward people speak in languages as rich and complex as French--and nothing discovered about the languages of the world since that time, seriously calls this into question. Even so, many of the several thousand languages in existence have no written form. As linguists are so fond of saying, writing is a very recent invention: very recent, indeed, relative to the great length of man's history. Man, in short, depends upon speech (upon sound rather than light)[13] so far as his most important communicative system is concerned.

Students of pictures have sometimes failed fully to grasp the implications inherent in the fact that man's primary symbol vehicle is speech. Indeed, students of pictures sometimes appear even to confuse writing and speaking. For example, it has been several times asserted that man has been communicating longer with pictures than with words. I believe that authors who have said this have usually meant to refer to writing; to the fact that picture writing is older than alphabet writing, though they have not always been explicit in this matter.[14] It seems likely, though, that speech predated both the development of picture and alphabet writing, and that both of these were built upon speech. This would seem to be the case because a prerequisite to all technology is some symbol system to make it possible for the organism to "bind time,"[15] hence to accumulate solutions to recurring problems; including the not inconsiderable problems connected with the production of the tools necessary for writing and picturing.[16]

4.4.3 Language, A System of Agreements. We have so far been saying, primarily, what language was not. What it is can now be stated rather simply. Language is a human system of communication based on vocally produced sounds. It is an arbitrary, learned system of agreements to let certain sounds stand for certain things, happenings, feelings, ideas, etc. It is an invention that makes possible the cumulation and transmission of solutions to commonly encountered problems, hence it makes possible the creation of a culture; and it is the most stable aspect of culture. It is an invention that makes it possible to direct one's own or another's thought to what is real, substantial, and present; or to what is imaginary, insubstantial, or distant in time or place. Non-language devices such as pointing, gesturing or picturing often suffice for directing attention to present and perceptible objects, but these usually fail when it comes to signifying the past or future, the hypothetical, the conceptual, or the relations that hold between objects independently of the objects related.

4.4.3.1 Language to convey relationships. Language deals with objects and with the relationships that can exist between them. Both are important. But language seems entirely necessary for conveying relations, while other means--pointing, gesturing, picturing--enable one to deal with objects. Objects can be directly seen if they are large enough and are directly presented to the senses, for they are the concrete, bounded entities of life: they are chairs, the moon, people, telephones, etc.[17]

Relationships, however, cannot be seen. Relationships in language are named, though, just as objects are named (Langer, 1942). Thus it is possible, with language, to call attention to relationships like "bigger than," "to the left of," "killed," "loves," "is the husband of," without naming any objects at all.[18] Of course in order to make sense, the objects related must be named. If these objects be "John" and "Mary," one could say, "John is bigger than

Mary," or "John is to the left of Mary," or "John killed Mary," or "John loves Mary," or "John is the husband of Mary."

Relationships between objects pictured or seen in the perceptual world are inferred. They are not directly seen. To illustrate this, let us hold in mind a picture of a football player kicking a football. The objects are the player and the ball. The relationship that holds between them is kicking. Now on first thought one might suppose that one could see kicking directly. But imagine for a moment that the scene is a photograph and that we use a pair of scissors to carefully cut out the picture of the football player, and the picture of the football. Once done, the relationship "vanishes." If we had worked with a drawing rather than a photograph, there might remain "swoosh" lines put in by the artist to indicate a rapid action. Moreover, the stance of the player remains and it is suggestive of kicking or some similar action. There would also remain the indentation in the football resulting from its having just been kicked. But even though these are suggestive of kicking, they are not pictures of it. An unaware observer, viewing our handiwork, might wonder why the player was standing as he was, or he might think that the football was flat and in need of air. And, even assuming he had noticed the "swoosh" lines, he likely would have no notion at all of what they had been intended to represent in the whole picture.

4.4.4 Logical Pictures. What was said above holds for a moderately to highly realistic picture or drawing, but not for what I shall call (borrowing a phrase from Wittgenstein, 1961)[19] a "logical picture." As used here, a logical picture is a visual representation whose objects (things, elements, visible bounded entities) are arbitrarily represented (e.g., by squares, circles, dots, or whatever); but whose relationships (between objects) are represented non-arbitrarily. Relationships, in a logical picture, are represented in a way that is isomorphic with the relationships that hold in the state of affairs depicted.

4.4.4.1 The varieties of logical pictures. In a logical picture, isomorphicity of symbol/referent relationships can take three forms. In what I shall call Case I, the elements in the picture are isomorphic with the state of affairs represented on two different counts: (a) with respect to the spatial arrangement of the objects depicted, and (b) with respect to the order of connection of those objects. An example is a road map. As in all logical pictures, the objects are arbitrarily represented. Thus cities and towns are represented on road maps by arbitrary geometric forms (small circles or stars) whose contours bear no relationship to the actual contour of the city's boundary line. Moreover, some objects are systematically falsified, as is road width in being represented as wider than scale. But the relative position of the mapped towns is isomorphic with the geographical arrangement of those towns; and the order of connection of the towns by the lines drawn to represent roads, preserves the identical order of connection of those same towns by actual roads in the state of affairs depicted. Thus one could begin at any point on a road map, follow a highway, turn at any junction, and do this for an indefinite length of time. The serial order with which one traced a path from town to town would be the same on the map as if one had traveled the route by car.

In Case II, the pictured arbitrary objects are connected in the identical order as are the corresponding objects in the state of affairs depicted (as just exemplified), but the spatial arrangement of the objects is arbitrary. A common example is the schematic wiring diagram used in radio and other electronic work. Not only are the objects (capicitors, resistors, etc.) arbitrarilly portrayed, but their positions relative to one another are also arbitrarily portrayed. It is only the order of connection of objects that is isomorphic with the order of connection of parts in the physically existing circuit represented by the diagram.

In Case III there is a spatial isomorphicity, but not isomorphicity of order of connection of objects. This can be illustrated if one imagines a photographically accurate drawing of a circuit, but with the order of connection of parts altered. Although logical pictures of this sort would seem, pragmatically, to be of little value, they may have didactic and theoretic uses. (For example, as in the recent work in constructing a model of the DNA molecule.)

The three cases enumerated can be summarized in paradigmatic form, as follows.

	Type of Representation			
	Case I	Case II	Case III	Case IV
Spatial Arrangement of Objects	Isomorphic	Arbitrary	Isomorphic	Arbitrary
Order of Connection of Objects . .	Isomorphic	Isomorphic	Arbitrary	Arbitrary

Examination of the above paradigm reveals that we have ignored a fourth Case. This is one in which the spatial relationships of the objects, and the order of their connection, are both represented arbitrarily. The reason for the omission, of course, is that the fourth case, in being totally arbitrary, does not classify as iconic under our definition.

4.4.4.2 Relevance for the student of pictures. In a survey of pictorial research, the authors ignore what are here called "logical pictures." (See Note 3, Chapter One.) This was done on the grounds that an interpreter had to learn the names of the pictured objects, these being represented arbitrarily. But, of course, the connections between objects may be represented non-arbitrarily; and to do so, is to make a most significant use of the iconic symbol. Indeed, it is only by means of the logical picture, where objects are arbitrarily represented, that it becomes possible, iconically, to unambiguously signify relationships between objects.

4.5 Words and Pictures

C. F. Hockett (1959, 1960-a, 1960-b, 1963) has exploited a remarkable insight of high utility for the student of pictures. His aim was to find a way of comparing animal communication systems (be they as diverse as those of man and honey bee), and his insight concerned an idea of how to do this. What Hockett did was to attempt to discover those design features of language that are (a) common to each and every human language system; but (b) lacking in one or more animal communication systems.

One such design feature is "displacement." Every human language is characterized by displacement, but among all the animal communication systems so far studied, it appears that only the bee has a communication system with this feature.

Displacement is a design feature of communication systems of the sort which makes it possible for the communicator to refer to things distant in space and (or) time. The bee, for example, can communicate the distance and direction of distant blossoms to other bees (Von Frisch, 1950).

Sixteen design features have by now been described (Hockett, 1963). And although it is impossible to know how complete this listing is, there is a great deal that can be done with the description now available. So far as the purposes of this monograph are concerned, Hockett's work has come to a point where it can facilitate the attempt to compare language and pictorial communication.

4.5.1 Differences Between Words and Pictures. Not all the comparisons made possible by Hockett's analysis are equally relevant to the present task. We consider the more relevant design features, grouped so as to highlight certain matters.

4.5.1.1 Talking is less effortful than picturing. The energy expenditure involved in symbol production is often minute and biologically inconsequential. If so, the communication system thus characterized is highly "specialized." Talking is probably the most highly specialized of all communication systems. Talking can be carried on simultaneously with many other activities. For example, the hands and feet can both be used without the necessity that talking cease. People can speak while walking, descending in a parachute, or even with their mouths full of food.

By way of contrast, the production of pictorial symbols (and writing, as well) is slow and tedious. These latter require the use of hands, arms, and tools; and, as well, their production requires a rather general immobilization of the body. Production of pictorial and written (verbal) symbols must, therefore, often cease, in order that other activities of higher priority may be gotten underway. Speech is thus more highly specialized than writing; and writing (possibly) than picturing.

4.5.1.2 Some differences depend upon the physics of sound. Three features described by Hockett (1963) fail to apply to pictorial symbols in exactly the same way that they fail to apply to writing;

for they are differences that relate to the physics of sound vis-a-vis the physics of light. These nevertheless have interest here, because of a second-order relation to "feedback" (as see 4.5.1.3). Hockett refers to these as: (a) "vocal-auditory channel"; (b) "broadcast transmission and directional reception"; and (c) "rapid fading."

Speech depends upon the vocal-auditory channel. Writing and picturing depend upon the visual-manual channel. Speech sounds surround the speaker for some distance, penetrating most barriers (including darkness), so as to be received by anyone within earshot (broadcast transmission and directional reception). Moreover, the ears do not close like the eyes do; and even in sleep the organism is (in some degree) always tuned to receive sound. This is why alarm clocks employ sound rather than light.

Writing and picturing are visual-manual activities, hence both transmission and reception are light-dependent and directional. These symbol vehicles are relatively permanent (lack of rapid fading).

4.5.1.3 Listening is speaking is listening. All languages have "interchangeability" and "total feedback" (Hockett, 1963). By "interchangeability" Hockett means to refer to the high degree of equivalence of that which is vocal and that which is auditory. As a consequence of interchangeability and feedback, a person who can interpret a language can also produce it. Barring the pathological case, a person can produce any message he can understand, and he can understand any message he can produce. A speaker can thus respond to his own messages in much the same way as does his interpreter; and in being able to speak to himself as to others, he can thereby internalize the whole communicative process.[20] In being enabled to respond to his own messages in ways similar to the way the recipient of his message will likely respond, he is enabled to "take the attitude of the other" (as G. H. Mead was so fond of putting it).

Compared to what is involved in the vocal-auditory case (with speech), visual-manual interchangeability and feedback as required in the production of written and pictorial messages, is a ponderous process.

4.5.1.4 Iconic symbols are necessarily semantic. Five of Hockett's 16 design features provide an especially illuminating basis for characterizing word/picture differences. These are: "semanticity" (which is considered in this section); "reflexiveness" (in 4.5.1.5); and "arbitrariness," "discreteness," and "duality of patterning" (which are inter-related in an interesting way, and so are considered together (in 4.5.1.6).

Semanticity refers to the fact that symbols make reference: they refer to ideas, etc. in the non-symbol world. Indeed, by definition, every iconic symbol is semantic; for an iconic symbol, as I earlier defined it, was said to be one that shared criterial attributes with its referent. If there is no referent, there is nothing with which the symbol can share criterial attributes.

However, a little reflection will reveal that not all language symbols make reference. Those that do not are called "formators" (Morris, 1946). Examples are words like "not," "and," "then," "is," "or," and punctuation marks. "Lexicators" (also Morris) are symbols that do make reference.

Formator symbols signify the function of other symbols. They "make reference" only in the sense that they direct the way a person responds to the _other_ _symbols_ with which they are associated in an utterance.

Consider, for example, the following pair of sentences.

1. John will go to school tomorrow.
2. John will _either_ go to school tomorrow _or_ he will _not_ go.

The formators "either," "or," and "not," are not _about_ anything; but they do change what is signified by the remaining symbols with which they are associated. They state that John has two alternative courses of action, of which he will choose one.

Formators are sometimes called "logical signs." In a logical argument (at least from the logician's point of view) the lexicators are unimportant and could be removed. The remaining formators would convey the logical _form_ of the argument; and it is the logical form that is of interest to the logician. In brief, _form_ators show (logical) _form_.

To illustrate: I could say that, "If it snows tonight, the roads will be slippery; and when the roads are slippery, the number of automobile accidents will increase. Therefore, if it snows tonight, the number of automobile accidents will increase." But so far as interest centers on logical form, I could as well say, "If A, then B; and if B, then C; therefore, if A, then C."

I would not labor an elementary point without a reason. I have in mind statements of the sort that urge the use of pictures in logical or discursive roles. Thus Ruesch and Kees (1956) urge development of a pictorial (analogic) metalanguage for talking about (picturing about?) pictures. They say this, even while recognizing that analogic symbols cannot be used discursively. Others have urged the use of pictorial tests on the non-relevant grounds that pictorial materials were employed in instruction. (Of course, the use of pictorial materials in tests is defensible and even mandatory in certain cases, as in testing a person's ability to visually identify objects as in aircraft recognition.)

The point, though, is this: iconic symbols are lexicators, never formators. Therefore, iconic-only messages are necessarily non-propositional. They are alogical. This is why it is impossible to "state," pictorially, that pictorial communication is superior (or inferior) to language communication, for any purpose. And this is why, of necessity, all polemics about pictures are verbal.

4.5.1.5 Iconic symbols are non-reflexive. In every language, one can talk about talking. Hockett (1963) calls this design feature "reflexiveness." But is it possible, also, to picture about picturing? Wendt (1956) says "yes." In Wendt's phrase, pictures are "self-reflexive," and for the reason that one can take a photograph of a photograph.

The distinction between knowledge *of* something, and knowledge *about* it, obtrudes here (as see 4.3.2) Clearly, one can take a picture of a picture; and one can take pictures of picture-taking. An analogous action to that of taking a picture of a picture, would be to copy a word in writing, or to mimic it in speech. But this is not what is intended by the term, reflexive. (Or, if it is, the point is granted. Also, it is as trivial as it is obvious.) But I would think that in a context such as the present one, the use of the term "about" shows that the intention is to refer to discourse upon the subject of "*talking*."[21] In this sense, one cannot picture *about* picturing for reasons stated in the preceding section: to do so one would need, but lacks, pictorial formators.

4.5.1.6 Iconic symbols are non-arbitrary, non-discrete, and non-syntactical. "Arbitrariness" is a design feature previously claimed as basic to the distinction between iconic and digital symbols. It is discussed here along with the design features Hockett calls "discreteness" and "duality of patterning."

"Discrete" and "continuous" are antonymous adjectives. For example, the number of chairs in a room is a discrete number, because this number will be one or two or some other whole number of chairs. It will never be 2.376 chairs. The dimensions of the room, however, are continuous. No matter how accurately measured might be a dimension such as the length of a room, a measure that is yet finer is always a possibility.

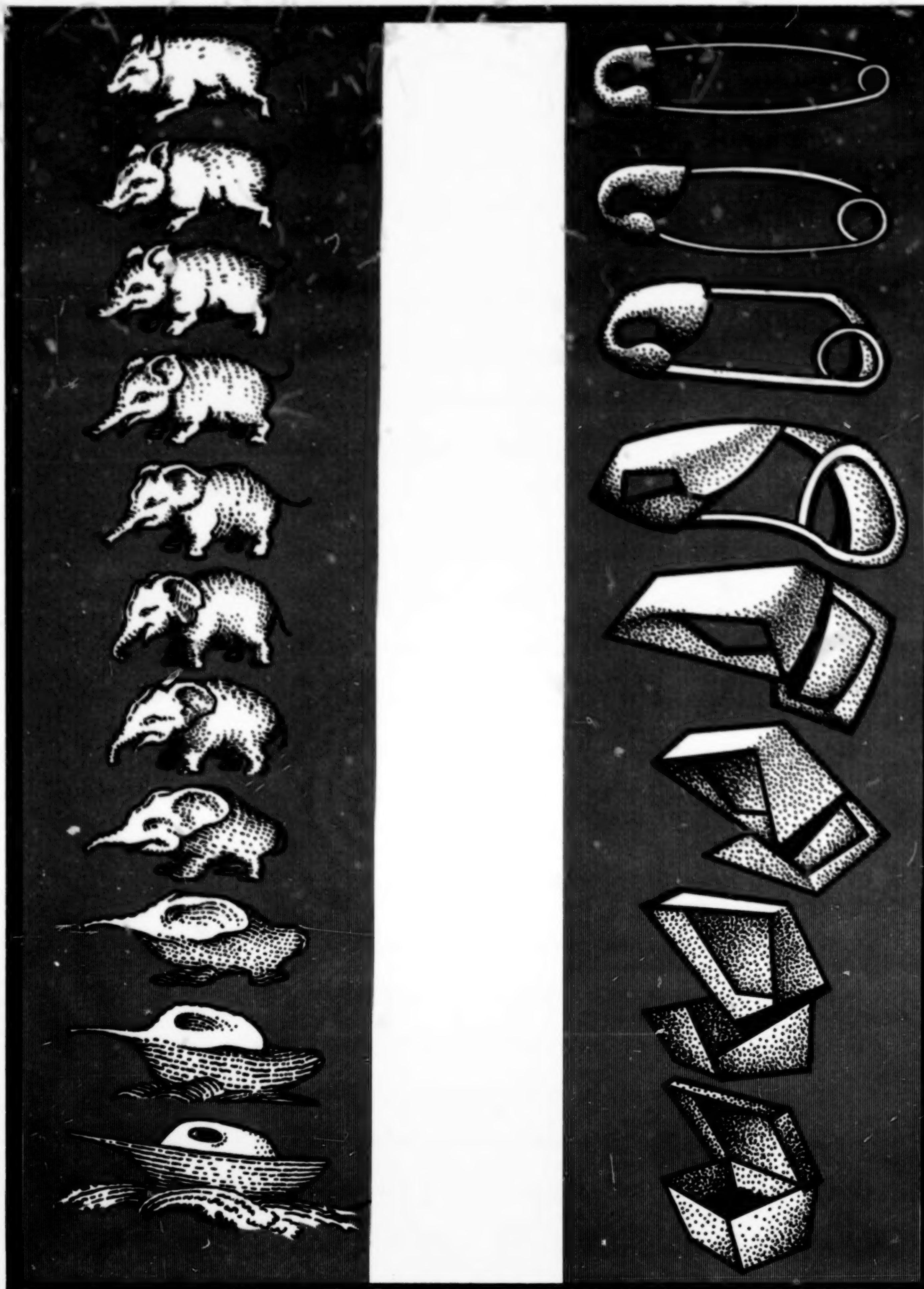


FIGURE 4.5 An "intuitive argument" for the position that an iconic semantic is necessarily a continuous semantic.

Iconic symbols, too, are continuous. The things in the world of men's affairs that can be represented by iconic symbols are continually changing, and iconic representations of these things can be indefinitely modified, employing as infinitely small changes as one wishes, so as to reflect any change with any desired degree of accuracy. One suspects, intuitively,[22] that iconic symbols are therefore continuous.

In Figure 4.5 is a pictorial illustration that suggests that an iconic semantic is continuous. The reader may have seen series of illustrations showing how an outline drawing of a cat can be made to change by small degrees to come to represent a dog. In Figure 4.5 is represented the much more ambitious undertaking involved in changing a pig to an elephant to a boat; and of changing a pin to a bin.

Language symbols are discrete. This may seem less immediately plausible than does continuity in icons, unless one lapses in his thought, and confuses writing and speech. The printed sentence has a highly visible quality of discreteness; but the sounds of speech range continuously along a number of dimensions, and slight but discrete and recognizable differences such as exist between the initial sounds in pin and bin typically make for a total difference in meaning.

But if the sounds of speech do indeed range continuously along a number of dimensions, as asserted, then if "discreteness" is a valid term with which to describe speech sounds, it must be the case that speech sounds are quantized (Hockett, 1960).

It is easy to imagine quantizing a unidimensional continuum such as a cross-country highway. A highway could be segmented by mileage markers; and to make things easier, one might decide to ignore alternate one-mile segments, and to mark the remaining segments in some distinctive way.

Language segments the range of speech sounds in a roughly analogous way, except that several dimensions of sound are involved simultaneously. For this reason, let us change the analogy from a highway to a hilly countryside, and let us agree to ignore the valleys (comparable to noise: equivalent to the igonred one-mile strips of highway) and attend to the hills. If a hill were thus analogous to a quantized sound unit, one could add that the nearer to top-center a sound was "placed," the more typical (average, recognizable) would that sound be. Near the edge of the top of the hill, the sounds would begin to lose their distinctiveness, and as if passing over the edge of a cliff, there would come a point where a small movement toward the periphery would cause a sudden decrease in recognizability. These analogies are rough, but I think they are accurate enough for our purpose.

It is this discrete character of the symbol vehicles of language that makes "duality of patterning" (or, as I shall refer to it: "duality of ordering") possible. Duality of ordering refers to two distinct levels in speech wherein ordering is critically important. At one level, reference is to the order of arrangement of very small sound units such as were implied by the foregoing analogy.

These are called "phonemes," and they combine to form words. On the other level, reference is to the order of arrangement of words in a sentence.

A phoneme is a minimal speech sound or category of highly similar sounds: those bunched closely on the hill top as in the preceding analogy. They are such as is represented, roughly, by a letter of the alphabet. For simplicity, I will speak as if the sounds represented by the letters of the alphabet, were phonemes.

Phonemes are both arbitrary and meaningless. Only as these quantised units of sound are fitted together to form words, is reference made. Consider the following: cat, rat, bat; or cut, rut, but; or cab, rap, ban. Here, by changing one sound at a time, the meaning of the word changes completely. And the same set of minimal sound units can be arranged differently to signify differently. Thus DOG : GOD. To impute anything of the former about the latter would be blasphemous, and one never thinks of the similarity of the component forms of these symbol vehicles, except as such examples are consciously sought to illustrate a point.

The other level where ordering is important, is the syntactical level. Examples are easy. "Otto killed Boris," for example, signifies differently than does "Boris killed Otto." A few words go a long way.

But do pictures have syntax? To begin with, the question is poorly put; and for a number of reasons. To ask if pictures have syntax is to imply that (a) there is an accepted definition of "picture," and (b) that pictures are symbols (or at least signs). But this last requires, in turn, that pictures have post-conceptual (most usually, post-linguistic) status.

More strickly speaking, the question is faulty (indeed, invalid) on quite another ground; for pictures no more have syntax than do words. A more proper question to ask is: whether or not interpreters of pictures employ combinational rules in their use of pictures, so as to systematically change what is signified when the same set of symbol vehicles is differently arranged. That this last is true seems doubtful.

But first, let us ask: what is a picture? If one thinks of a picture as a visual-iconic representation bounded by a white or black (etc.) frame as in the usual vernacular sense, then the elements to be arranged according to rules, are these same framed entities. This is often intended, as seems to be the case when it is asserted that it is in the motion picture that one finds "the syntax of photography" (Wendt, 1956). On the other hand, it is often asserted that the single particular objects that are represented within the frame of a single picture (as defined above) are the elements that are manipulated, and that pictorial syntax refers to rules concerning this sort of arrangement. The loaf of bread, the jug of wine, the cheese; artfully arranged upon a checkerboard tablecloth, there to be arranged again, and rearranged: this is the "syntax" referred to last. No one doubts that such changes in arrangement change something; but what is changed? I would suppose that connotations, at least, are changed; though if only connations are changed, such changes could hardly be thought to be regular and systematic for any definable interpreter family.

Language has a vocabulary and a syntax. Words are the pieces of the game, and they could not be manipulated so readily as they are, were they not characterized by discreteness. This is dramatised in arithmetic where a fixed value can be represented in an infinity of different though perfectly equivalent ways: $8 = (4 + 4) = 2^3 = (99 - 91)$, forever. In language, the same thing happens, though the number of alternative ways a referent could be signified, seems at first thought to be finite in number.[23] But we do not have to decide this. The only point of the comment, is that in language there are enough choices among equivalent expressions, to make the writing of a dictionary a possibility (Langer, 1942).

In contemplating the possibility of a pictorial dictionary, one wonders about several things. For example, it might be argued that texts like that of Richards, Metcalf and Gibson (1953), for teaching Spanish to an English speaker without dependence upon the learner's English (either spoken or written) is such a dictionary. Then, too, usual dictionaries use pictorials to help define words in a certain highly predictable category of cases.[24] In neither of these instances, though, are pictures used to define other pictures. Indeed, such a need is hard to imagine. A picture, if it were a symbol, would be post conceptual and already "defined" for the interpreter for whom it was a symbol. If it were a non-symbol visual display, it would "mean" what it was; it would not stand for something else, and such questions as are being posed here become non-sensical.

To summarize: Pictures, as iconic symbols, lack arbitrariness and discreteness; hence syntax is ruled out at once. The elements within a picture also lack discreteness in that they are highly context bound. Independent of context, the elements of pictures lack any meaning at all. The same elements (physically) may recur, but they will be so context bound that they will be unrecognized as such--i.e., as elements (Langer, 1942). Being non-discrete and non-arbitrary, their complexity cannot be sufficiently limited.

4.5.1.7 Iconic symbols are "truthful." There are two design features found in all languages that make it possible for man (a) to lie, and (b) to say things he has never said before, and be understood. Hockett (1963) refers to these as "prevarication," and "openess." We consider only the former of these closely related pairs.

The ability to prevaricate is of immense importance to modern-day man.[25] Because of this design feature, present in all languages, man can refer to things such as unicorns, round squares, virtuous prostitutes, and the square root of minus one. Man can utter morally vile lies; but then he can also hypothesize as does the scientist. If man could not prevaricate, he could neither hypothesize or theorize nor use emphasis to highlight what would otherwise be an ignored subtelty.

The heading of the present section asserts that "iconic symbols are 'truthful'." This folklore idea--that pictures do not lie--is one we are now equipped to examine critically. It will be helpful to begin by putting this notion in question form: "Do pictures lie"?

Put thus, the question is invalid, for it contains the implicit invalid assumption that pictures can state propositions, true or untrue; but pictures cannot take a propositional form, for they lack formators. Pictures can, of course, mislead. It is easy, for example, to create a misleading set of circumstances by manipulating the non-symbol world, and then making a photographic report of it. One can also photograph the non-symbol world selectively, thereby giving the impression that isolated instances are typical ones. And one can manipulate the picture itself in processing. All these things can of course be done using drawings, paintings, or whatever.

But as already implied these are all quite different matters than is the verbal statement of a false proposition. The fact that there are no pictorial formators means that pictures cannot state false propositions, because pictures cannot state propositions at all. In the quite different realm of the psychological, however, pictures do sometimes increase or decrease the credibility of verbal statements. Thus pictures of missile sites were displayed before the United Nations assembly, and the United States ambassador to the U. N. asserted that these were Cuban missile sites. These pictures, even though they could as easily have been photographs of U. S. missile sites in Montana, as sites in Cuba (for all that most interpreters could know), nevertheless seemed to lend credence to the ambassador's words.

4.5.2 Similarities Between Words and Pictures. Word symbols and picture symbols are very different animals. And it is the matter of differences, not similarities, that is the concern of he who wishes to exploit the icon to enhance a communicative effort. Even so, it is sometimes useful to alternately place different emphases when trying to understand difficult problems. In this concluding section, I would therefore like to point up some of the similarities of icon and digit.

4.5.2.1 Universal, conventional, and accidental meaning. While it is generally true that pictures tend toward lifelikeness, and words do not, word vehicles used poetically can function almost as if they were a rather opaque breed of sign, and schematized barren pictorial vehicles can function almost as if they were a rather transparent[26] breed of sign.

The point is rather interestingly made by Marti-Ibanez (1960), who considers all signs to have three "meaning components." These he labels as: (a) a "conventional" component, (b) an "accidental" component, and (c) a "universal" component.

The conventional meaning component is learned, and arbitrary signs (like words) are to be thought of as very largely conventionalized; though not totally. The exceptions may be trivial for most purposes (as is true in the case of onomatopoeia or phonetic symbolism).

And while the conventional component is much reduced in the case of iconic symbols, it is nevertheless present in noticeable measure.

The accidental meaning component is what is often intended by the phrase "connotative meaning." Reference is to the "chance" happenings (or the idiosyncratic experiences) of an observer that result in his giving some additional interpretation to a sign beyond what is given in the signs conventionalized or universal meaning. For example, "mother" may name a concept having a fearsome affective component for some particular person, whereas the presumed affective standard is one of "sweetness and light."

The universal meaning component refers to whatever the qualities are that make icons easy to learn to read. It seems likely that even words have a small element of "universal meaning" as exampled by the trivial instance of phonetic symbolism.

4.5.2.2 A modification of the Ogden-Richards' triangle. Marti-Ibanez's idea is suggestive. However, the notion of a universal meaning component seems vague. Looked at a little differently, though, it becomes possible to change the germ of Ibanez's thought into a simpler form. To do this involves us with the classic "triangle of meaning" popularized by Ogden and Richards (1923).

It was earlier asserted that a sign directs behavior with respect to something else. The something else is a referent category. Sign and referent are not directly connected, however. That is, signs do not direct things, but rather, behavior towards (or thought about) things.

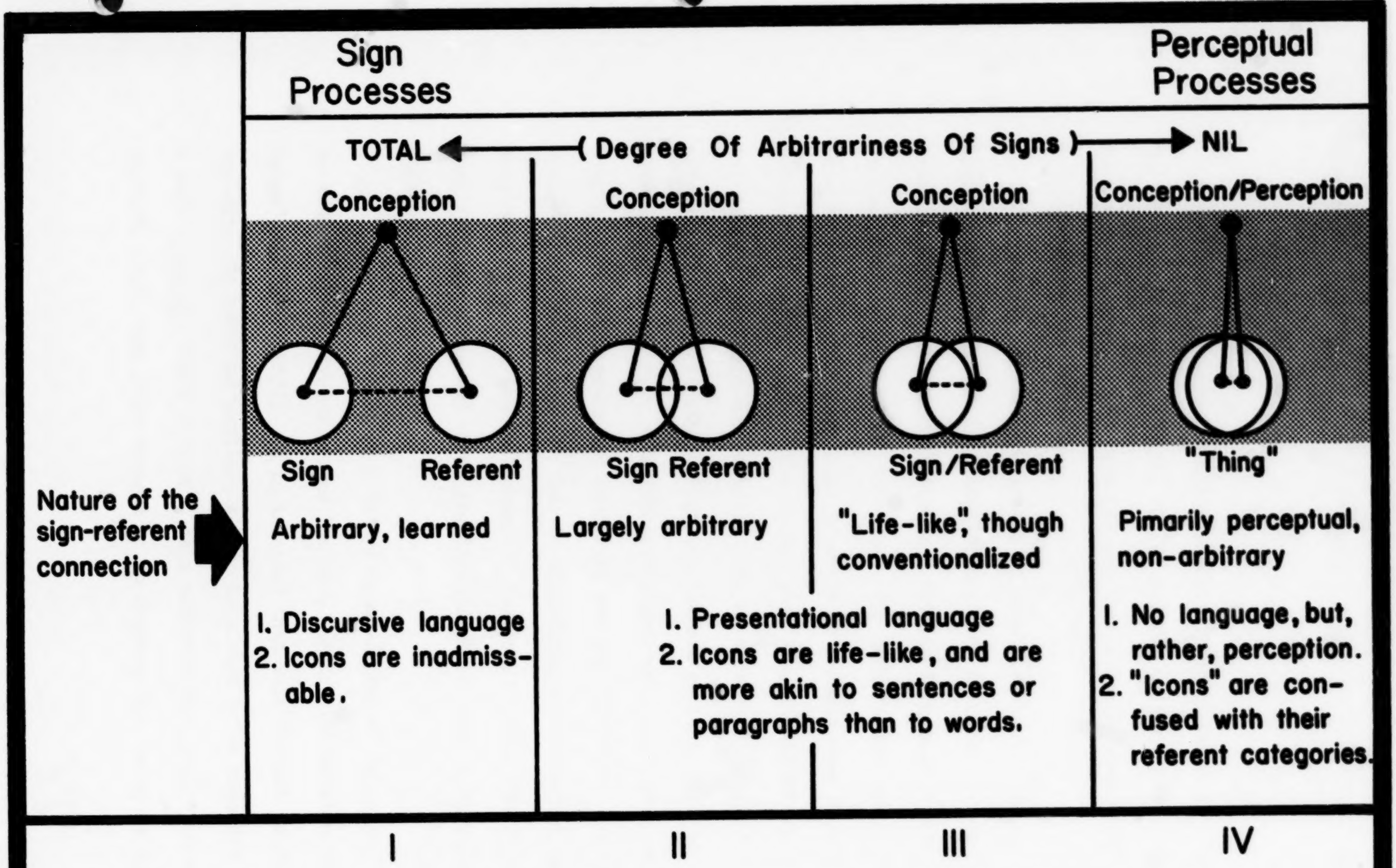

Sign Processes
Perceptual Processes
TOTAL ← (Degree Of Arbitrariness Of Signs) → NIL
Conception
Conception
Conception
Conception/Perception
Sign
Referent
Sign Referent
Sign/Referent
"Thing"
Nature of the sign-referent connection
Arbitrary, learned
Largely arbitrary
"Life-like", though conventionalized
Pimarily perceptual, non-arbitrary
1. Discursive language
2. Icons are inadmissable.
1. Presentational language
2. Icons are life-like, and are more akin to sentences or paragraphs than to words.
1. No language, but, rather, perception.
2. "Icons" are confused with their referent categories.
I
II
III
IV

FIGURE 4.6 Some effects on interpretation that result from varying the degree of "arbitrariness" of iconic signs.

This was perhaps the most central notion of Ogden and Richards' The Meaning of Meaning (1923), for it relates to the central fallacy they were concerned with: the fallacy that symbols record or communicate events or facts.

In Figure 4.6 is represented an extension of the Ogden-Richards' triangle. It is intended that this illustration suggest that the similarities and differences between icons and digits can be ranged along a true continuum. The left-hand triangle is labeled Roman I, and this first triangle is a close copy of the Ogden-Richards' triangle. The dotted base line should be taken to indicate that sign and referent have no necessary (intrinsic, natural} connection; rather, that the connection is inside the interpreter in the form of a concept or referent--involving, presumably, some kind of language-caused change in the functioning of the nervous system. The connection referred to is arbitrary and learned, and this makes possible the employment of discrete signs. This, in turn (if, given syntax) makes possible the existence of discursive language.

One change I have made in the Ogden-Richards' triangle, is to add the white circles around the base corners (those standing for "sign" and "referent"). It is intended that this suggest a spatial analogy. As asserted earlier, a sign is always to be regarded as a sign category, and a referent, as a referent category. These circles, then, are to be thought of as representing category boundary lines. In the Roman I case, where there is no overlap of the sign/referent categories, it is intended that this fact should indicate a total lack of commonality of any criterial attributes as between sign and referent categories. This is simply a way of saying that the relationship depicted is arbitrary, hence, non-iconic.

Roman II in the illustration is similar to Roman I, except for a slight overlapping of the sign/referent boundary lines. This should be taken as picturing the state of affairs that exists when highly schematized iconic signs are employed. In Roman III, where sign/referent overlap is yet greater, the intention is to suggest the situation wherein rather lifelike signs are used.

Roman II depicts the case wherein the iconic signs that would be categorized there, are so highly schematized that it should ordinarily be possible to make reference to equivalence categories. Examples would be such as those found in the language-through-pictures texts authored by I. A. Richards and his group (e.g., Spanish Through Pictures by Richards, Metcalf, and Gibson, 1953). The status, as symbols, of the representations in the Roman II case, would not ordinarily be in doubt unless the signs that were employed were employed by an interpreter family whose members had heterogeneous linguistic histories.

Roman III depicts the case in which the iconic signs are so lifelike that they are restricted (by that fact) to the signification of identity categories. In the Roman III case their would often be doubt as to whether the representations involved could validly be thought of as symbols, or whether it would be more justifiable to regard them simply as visual displays. Whatever the case, the "sign" types pictured in the Roman II and Roman III cases do not comprise any form of language as that term is used here. Primarily, this is because all such sign "systems" are necessarily nonsyntactical. The description of them in Figure 4.6 as "presentational language"--this is Langer's (1942) phrase--is an error in light of the terminology followed in this monograph.

Roman IV is intended to depict the state of affairs wherein sign and referent are confounded. Said otherwise, no signs at all are involved in the Roman IV case. In this circumstance, the conceptual language of semiotic is no longer relevant. Rather, the area of interest is perception, per se; and the conceptual language of perception would be most useful. One thus deals indifferently (in the Roman IV case) with the visual world directly, or, with visual displays of it. ("Indifferent" should not be taken to mean pragmatically unimportant, for there may be important practical reasons for choosing reality in one circumstance, and visual displays or copies of it in another circumstance.)

Notes to Chapter Four

1. Onomatopoeia is an exception to this statement. However, it is an exception that is ignored here, because it is trivial for most educative purposes.

2. Osgood, Suci, and Tannenbaum (1958) conclude that pictorial symbols are "a very arbitrary class of visual signs . . . whose significance must be learned, just as the meaning of orthographic signs on the printed page must be learned" (p. 296). If reference is to the fact that iconic symbols are post conceptual (4.2), there can be no argument with this position. However, the example given by Osgood et al. seems likely to lead one to a different sort of conclusion.

For example, these authors cite such evidence as the fact that Bantu Negroes are unable to identify a clear picture of a horse. Persons living in cultures where pictures are nonexistent, apparently do sometimes fail to recognize pictures of familiar objects, when pictures are first encountered. But the ability to read pictures is rapidly generalized, once "the hang" of seeing objects in pictures is grasped. This ability (once the "hang of it" is gotten) instantly generalizes to the reading of all kinds of pictures. Thus Hochberg and Brooks (1962) report the case of a 19-month-old who had been raised in a pictureless environment. This child could appropriately name pictures of all the familiar objects whose names he had previously learned; and he could do this upon his first exposure to these pictures.

3. Brown (1956) gives a similar definition.

4. Langer (1953) presents this position with unusual clarity.

5. For Langer (1942), signals (which she calls "signs") are three-part, as here. However, she regards symbols as four-part: organism, symbol, conception, and object. More recently she has given a broader and vaguer definition of symbol (or "symbolic element") as follows: "Any device whereby we make an abstraction is a symbolic element, and all abstraction involves symbolization" (Langer, 1962, p. 60). The effect of this redefinition seems to be to remove the requirement that symbols make reference! What Langer is trying to do--and this may justify her drastic about-face--is to redefine symbol in a way so as to include all that has previously been included, and art forms as well.

6. Langer (1942) has stressed the necessity of making pictures barren of detail if they are to signify more than the narrowest of categories.

7. As was demonstrated in the previous chapter, this problem boils down to the matter of category invention, not discovery. Even so, "sign" is the fundamental term, and once a certain definition of sign is accepted, then the existence or non-existence of signs that are iconic cannot be a matter of someone's whim.

8. This long but not widely recognized distinction is elaborated by Langer (1953). I believe Bertrand Russell was first to explicate it.

Notes to Chapter Four (continued)

9. For example, see Dale (1954).

10. The notion of a single symbol is not as simple as it may first appear. The distinction between "word" and "morpheme" suggests the complexity of this problem. Following Bloomfield, a word is "a form which may be uttered alone (with meaning) but cannot be analyzed into parts that may (all of them) be uttered alone (with meaning)." A morpheme is " a recurrent (meaningful) form which cannot in turn be analyzed into smaller recurrent (meaningful) forms" (Bloomfield, 1961, p. 28). Thus "go•ing" is a single word composed of two morphemes.

11. It might be noted, in this connection, that a "single" language symbol is very much like a "single" picture in that it "says too much." The single word "man," for example, refers to all men living and dead, and yet to be born; to "primitive" man and to "technical, literate" man. It is seldom, however, that the term man is used with the intention of denoting so broadly as this. However, in the case of words, it is simple to narrow the range of denotation of a single word, by stringing modifiers in front of it: thus, American man, contemporary American man, the man next door who lives in the pink brick house.

With pictures, the problem is not that of narrowing denotative range, but of broadening it. A realistic picture denotes very narrowly indeed. To denote more broadly, the pictorial symbol has to be schematized, as is noted in the text.

Notes to Chapter Four (continued)

12. It appears that all the languages of the world are equally adequate to the demands of their users. This is not to say that there are no differences in the efficiency with which different languages encode different facets of their speakers' existences. Whorf's (1956) work, for example, provides abundant evidence that languages do differ in this respect. But whereas language A may be more efficient than language B with respect to encoding matters, w; language B may well be superior to A when it comes to encoding matters, x, etc. The discovery of better criteria, more powerful analytic tools, or a new, not-before-described language, could of course require an amended judgment.

13. It is no doubt correct, as Langer (1962) has argued, that language could not have developed if man had lacked either the sense of sound or of sight. But once language had evolved, the sightless person might very well be able, more readily, to learn the language of his group than could the deaf person. And, apparently, this is so.

14. Wendt (1956), for example, has asserted this--that man has been communicating longer with pictures than with words--without being explicit as to whether he intended "word" to refer to writing or speech or both.

15. I believe this phrase was coined by Alfred Korzybski.

Notes to Chapter Four (continued)

16. There have been recent discoveries (summarized by Washburn, 1960) that change some long-held beliefs. In particular, it is probably not accurate to equate the emergence of man from non-language near-man, with the beginning of the use of (any kind of) tools. The evidence has become convincing that near-man used pebble tools (unshaped rocks) before he had language or even a very big brain; and that (pebble) tool-use selected out big brains very rapidly. However, these discoveries do not necessarily change the conclusions recorded in the text, if the reference to "tools" is restricted to those tools that are shaped by their users.

17. "Objects" may more generally be thought to be whatever it is that lexicators signify. Sacrifice of generality is necessary, though, in order later to draw better parallels when the use of pictures is considered in a concept learning situation.

18. "Relationships" may more generally be thought to be whatever it is that formators signify. Sacrifice of generality is indicated for the same reason given in footnote 17.

19. I do not follow Wittgenstein's definition of "logical picture," although his work (especially as interpreted by Susanne Langer) suggested to me the notion of logical picture given here.

20. Bruner has this to say on the subject: "For it is the internalization of overt action that makes thought, and particularly

Notes to Chapter Four (continued)

the internalization of external dialogue that brings the powerful tool of language to bear on the stream of thought. Man, if you will, is shaped by the tools and instruments that he comes to use, and neither the mind nor the hand alone can amount to much" (from the introduction to Vygotsky's Thought and Language, 1962, pp. vi-vii).

21. The following paragraphs from Gulliver's Travels provide an insightful comment relative to the point in the text.

"We next went to the school of languages, where three professors sat in consultation upon improving that of their own country.

"The first project was to shorten discourse by cutting poly-syllables into one, and leaving out verbs and participles, because in reality all things imaginable are but nouns.

"The other, was a scheme for entirely abolishing all words whatsoever: and this was urged as a great advantage in point of health as well as brevity. For it is plain, that every word we speak is in some degree a diminution of our lungs by corrosion; and consequently contributes to the shortening of our lives. An expedient was therefore offered, that since words are only names for things, it would be more convenient for all men to carry about them, such things as were necessary to express the particular business they are to discourse on. . . .

Notes to Chapter Four (continued)

This having only this inconvenience that if a man's business be very great, and of various kinds, he must be obliged in proportion to carry a greater bundle of things upon his back, unless he can afford one or two strong servants to attend him." (Jonathan Swift, Gulliver's Travels, in Great Books, Volume 36, p.111)

22. The intuition that an iconic semantic is necessarily continuous, is apparently strong. My students, at least, nearly always accept this implicitly. This idea can also be defended, if not proved (as see Hockett, 1960), though I do not undertake to do so here.

23. This statement may be incorrect. It is probably the case that, logically, there is no longest sentence in the English language. If so, the number of alternative ways a referent could be signified would seem to be infinite in the case of language, just as in arithmetic. (See Chomsky, 1962.)

24. Dictionaries picture the readily picturable. That is, they picture instances of a referent when the referent category is narrow enough that a high degree of schematization is not required. For example, most dictionaries will not picture a dog, but they will picture particular breeds of dogs.

25. It would seem a real possibility that near-man had the ability to prevaricate before he was in a position to develop speech (Sturtevant, 1947). This idea is developed here because

Notes to Chapter Four (continued)

of its intrinsic interest; and what follows should not be taken as something to be believed, but as a (hopefully, suggestive) speculation.

If it is true that communication by means of expressive gestures preceded voluntary communication, it then seems plausible that the demands put upon near-man in order to survive, might have included a need to prevaricate. This is because the expressive gesture, inherently, is sincere; and, therefore, sometimes unhandy. As long as pre-man's needs were not aborted by the way his expressive behavior caused others to respond toward himself, he would have had no need to prevaricate. But this would not always be the case; and so if it were possible to act (in the sense of an actor playing a role), it seems that man would have found it convenient, at times, to play a role.

But how could pre-man get a-hold of such an idea? Sturtevant gives plausible examples. Here is another. Pre-man's spouse, who got only the leftovers from the meat table--when, indeed, there were any--was one day too ill to scramble for her ration. Her "husband" who had a little regard for her (though only as a convenient sex partner), observed her agonized moaning and, for the first time, presented her with some meat. This happened a few times. One day the "wife" was especially hungry, but otherwise feeling fine. The meat ration was

Notes to Chapter Four (continued)

especially limited and she almost began to feel ill from the thought of continued great hunger. At this moment she caught on to the idea of pretending illness though she did not feel it. Her act insured her ration, and was therefore well remembered, though she learned to use it only sparingly. When and if such a momentous thing happened, the biggest leap of all would have been accomplished: that from signal to symbol.

26. Quine (1960) credits A. N. Whitehead and Bertrand Russell (in Principia Mathmetica) for the term "transparency." I have defined a "transparency-opacity" continuum elsewhere, as follows.

"Much stressing of the value of lifelike surrogates can be found in the audiovisual literature. As used here, the transparent-opaque continuum refers to this quality, or the lack of it. Thus 'lifelike' and 'unlifelike' correlate with 'opacity' and 'transparency' respectively.

"The transparency-opacity continuum is better illustrated than explained. An interpreter of a surrogate generally does no more than quickly sweep across the surrogate, scarcely ever seeing it, for he is too busy seeing through it to the referent category. This is most easily seen to be true in the case of unlifelike surrogates such as words. The word 'dog' is never taken as a real dog except in cases of word magic. And if the reader will think back on what he has read in the last few paragrphs, it is doubtful that he had any images of words as

Notes to Chapter Four (continued)

the ink-on-paper, or the black-figure-on-a-white-background thing that is their physical character as stimuli. As surrogates, they are transparent. One does not 'see' them, but one does 'see,' in his mind's eye, the referent categories for which they stand as surrogates.

"When a stimulus that is ordinarily a surrogate loses all transparency, it loses its status as a surrogate. The reader can demonstrate this for himself. Try looking at the word 'dog,' and continue looking at it while saying the word over and over again. Sooner or later 'dog' will become a nonsense form. One's attention will cease to be directed to one's concept of doghood; rather, it will be directed to the now meaningless ink-on-paper markings that look like this: dog. 'Dog' has become a pseudo-surrogate, for opacity is total, mediating processes have ceased, and the stimulus is the object (Knowlton, 1964, pp. 12-13).

That words sometimes function as rather opaque signs, is suggested by T. S. Eliot who holds that words can evoke an emotional response (as in good poetry) only if they evoke striking images (or internal icons, as it were). That pictures sometimes function as rather transparent signs, is suggested by the language-through-pictures texts (e.g. Richards, Metcalf and Gibson, Spanish Through Pictures, 1953), where all the pictures used are highly schematized, and are frequently made to stand for single words.

5.0 WORDS, PICTURES AND CONCEPT ATTAINMENT

> The gauge of the child's level of development is not what he has learned through instruction but the manner in which he thinks on subjects about which he has been taught nothing.
>
> -- Lev Vygotsky

I asserted in the first chapter that the person interested in understanding pictorial communication must focus primarily upon behavior, not the pictorial symbol vehicle. We are in a position, finally, to begin to do this. However, we now concern ourselves with a range of problems that is primarily empirical, and we shall often find ourselves limited by the meagerness of the available data.

In the first part of this chapter I say some things about animal learning, and child learning of language. This may seem unrelated to pictorial communication; but it will be seen that through a discussion of this topic, it is possible to cast light on an old argument having to do with the relative importance of pictures in instruction as this is a function of developmental level. As was implied in the introductory chapter, our discussion of animal learning is not intended to be by way of proving anything at all about learning in humans, or even in animals.[1] Rather, it is by way of sharpening our critical faculties in order that we might be more successful in the formulation of valid and useful questions in the realm of pictorial communication. We shall see in this area, as in "media" research, that invalid questions have often been asked.

5.1 Some Phylogenetic Considerations

5.1.1 Contingency Learning in Animals. A child's first utterance of word sounds is one in which the sound is not a true word, but is taken by the child as an attribute of the object with which it is paired (Vygotsky, 1962; Church, 1961). The word "milk," for example, is likely to be rather regularly uttered by the mother upon the occasion of her gift of a glass of milk to her child. So far as the child can tell, the sound, "milk," is thus an inextricable part of the larger situation of which a glass of milk is a not inconsiderable part. In brief, the "word," is not a word because it is not a symbol, but a signal. Later, when this sound becomes a true word (hence a symbol), it will then be responded to by the child as the name for, not an attribute of, the associated object, the glass of milk. At this point the word becomes "detachable" from its referent (as we earlier phrased this matter when discussing symbols). This occurs at about the age of two; and, as Vygotsky quotes Stern, this is "The greates discovery of [the child's] life" (1962, p. 43).

In animals, there is a type of learning that in its complexity, and in the fact that it requires "contingent learning" (in a sense explained below) is remindful of language learning in children. For example, chimpanzees have been taught by circus trainers to drive cars, and to start and stop their vehicles as guided by red and green stop-and-go lights. These lights appear to guide the chimp's behavior in the way signals do, in that the signal lights appear to be a part of a global "stopping-behavior" phenomenon or "going-behavior" phenomenon.

At first, the automobile-driving chimp "goes" on green despite contingencies such as the presence of an obstruction in the intersection. But the chimp can be trained to respond in a way that takes this into account. In an argument on the relative merits of a chimp and a human driver, the human proponent can always say, "Yes, but the chimp wouldn't know what to do if. . ." etc. But then the animal proponent can always build into the chimp a response sequence that takes care of any such stated contingency. The limits to the complexity of animal learning, as Brown (1958) has suggested, seem more likely to be set by the endurance of the experimenter or the length of the animal's life, than by any limitation intrinsic to the animal's intellect.

The question we are asking, though, is not whether animals below man can learn to respond contingently. It is clear that they can. Rather, the question we ask is this: What is it that is involved in contingent learning in animal and man; and are the processes involved in the two cases the same, similar, or different?

An instance of what appears to be contingent learning is seen in two-year-old children. A two-year-old begins to form what appears to adults to be two-word sentences. Thus if a two-year-old has learned two words that can function as subjects of sentences (say, N-1 and N-2), and two that can serve not only as subjects, but also as predicates (say V-1 and V-2), he may be able to form eight different utterances,[2] as follows.

One-word Utterances	Two-word Utterances
N-1	N-1 + V-1
N-2	N-1 + V-2
V-1	N-2 + V-1
V-2	N-2 + V-2

But the child might accomplish this feat either by learning four different words and a rule (or rules) of syntax, or he might separately learn eight different and distinct utterances.[3] The first kind of learning is the most efficient, of course; though perhaps not noticeably so in the limited case described. But with a few hundred words and only a very small number of syntactical rules, a somewhat older child can generate thousands of coherent utterances that would be understandable by another, and he can do this even though he has previously heard none of them. He would also be able to solve certain classes of problems correctly on first trial. If, on the other hand, no combinatorial rules are learned, each contingency (each new combination of signs in the present example) would have to be separately practiced to be learned. There may be virtually no limit to the complexity of the contingencies that could be learned in this manner, but each of these, in having to be separately practiced, would, when taken together, add up to a prodigious learning task.

5.1.2 Learning to Learn. The work of H. F. Harlow (1959) and others[4] on what is called "learning-set" learning is especially valuable in trying to understand the present problem: because

(a) higher animals have generally been used (b) in solving complex problems (c) requiring contingency solutions and (d) the results have indicated that learning efficiency in this kind of learning situation is more highly correlated with phylogenetic rank than has typically been found to be the case.

Harlow had an early interest in "learning to learn" or "transfer of training." This phenomenon covers the case where an English speaker, for example, in having learned French, can then learn Spanish more readily than if he had not first learned French; but that, still, his speed in learning Navajo, for instance, may not have been noticeably increased by his study of French. This phenomenon is probably a general characteristic of all learning. That is, learning effects are probably never limited to the precise set of circumstances existing during the several instants of practice, and so phrases like "transfer of training" or "learning to learn" are technically redundant.

Harlow recognizes that his learning-set research can be regarded as simply another instance of transfer-of-training. However, he prefers to believe that it is something more than this, and he draws a possibly valid distinction designed to encourage our agreement with him in this matter. The transfer Harlow has interest in is transfer of a learned ability between distinctively different problems. These "distinctively different" problems (despite seeming distinctiveness) are nevertheless similar in that the behavior required of the animal for their solution, necessitates the animal's learning of a common pattern of responding. It is necessary for the animal to learn that this common pattern remains valid, though the experimental milieu in which the animal finds itself, is one in which the stimulus objects are ever changing. If given training on a sufficient number of these "similar" but "distinctively different" problems, the animals efficiency in solving the remaining "similar" but "distinctively different" problems will be high if not perfect. (Now, obviously, "similar" and "distinctively different" are, on the surface, hardly compatible notions in this context. But these terms were selected for this quality, for a reason that will become apparent.)

A typical experimental procedure in learning set studies is one that finds a primate in a jail-like cage. Two perceptually distinctive stimulus objects covering food wells are located on either side of a food tray which is placed before the animal's cage. The animal can reach between the bars of his cage to remove one or the other of these stimulus objects. When the to-be-rewarded object is removed by the animal, a bit of food is revealed. The pattern of rewards may be such as left/right alternation, or something much more complex as explained below.

Harlow's idea was to define a category of "similar" problems, and to give an animal a limited number of trials (usually six) on each of a very long succession of these. Under these conditions, learning is at first slow. In time, though, the animal comes to respond correctly either on first or on second trial. If correct on first trial, the animal will maintain that response; if incorrect on first trial, the animal's response on second trial will be correct and thereafter maintained. In Harlow's interpretation the animal gradually proceeds from trial-and-error, to insightful, learning.

Some of the more complicated problems solveable by non-human primates are of a sort requiring contingency learning. In one of these (Harlow & Harlow, 1949), three objects were U-shaped, one was +-shaped. One U and the + were a common color; the other U was a different color. Of the three objects, one (one of the U's) was thus distinctive in color, another (the +), in shape. The animal had to learn to choose the odd-*shaped* object when the tray upon which they were placed was one color, and the odd-*colored* object when the tray was a different color.

One seemingly important reason why learning set phenomena cannot be written off as just another case of transfer of training, is the fact that phylogenetic rank correlates more closely with the ease with which learning sets are learned, than with the ease with which an animal learns the solution to "single" problems. Miles (1957), and Miles and Myer (1956), have thus shown that the Rhesus monkey excels the squirrel monkey, and the squirrel excels the marmoset in learning-set learning. Apparently, the marmoset, in turn, excels the cat, as Meyers, McQuiston and Miles (1962) have shown. However, these last authors disclaimed having demonstrated a species difference on grounds of conservatism.

Learning-set learning procedures require considerable training; but training of only a few trials in length on each of many "distinctively different" problems of a category of "similar" problems. Thus one wonders in what way(s) these "distinctively different" problems are "similar," and in what other way(s) these "similar" problems are "distinctively different."

As Restle (reported in Harlow, 1959) has analysed this, there are relevant cues common to all problems of a category, and these become "conditioned" and transfer from problem to problem. Other cues are relevant only within a problem and these, in time, become "adapted." A third class of cues are irrelevant and become adapted.

Our own metalanguage allows for at least one additional distinction. We would say that there are criterial and noncriterial attributes available in all problems. Some of the non-criterial attributes will be noisy, and have to become "adapted," while others will be quiet (i.e., already "adapted"). Some of the criterial attributes will be only potentially criterial in the beginning, but with training, will come to have actual criteriality. Attributes that are criterial and common to all problems are the attributes in terms of which one can speak of similarities between problems. However, some attributes will be criterial for one problem, but not for another; and so these will not be criterial for learning the learning set. Indeed, they must be described as noisy. The attributes that are criterial for some but not all problems, are the attributes in terms of which one can speak of a set of distinctively different problems.

Psychologists have traditionally set a problem for an animal and observed the learning process through the course of this "single" problem. The experiment ends and is reported. Harlow (1959) points out that these "single-problem" studies give no evidence for a phylogenetic ranking, whereas the ability to form learning sets does correlate with evolutionary position.

But what, forsooth, is a "single" problem? It seems to me that the earlier mentioned matter of "similarity" or "difference" between (within?) problems (a problem?) is secondary, though related, to the question of what is to be intended by "a single problem." Ordinarily there is no difficulty in defining a single problem in animal studies; and, indeed, this is not generally recognized even to be a problem. A single problem is (a) what the experimenter says that it is, or (b) what the animal must do before the experimenter is willing to agree that the animal has been successful. Ordinarily these two things are the same thing; but not so in the writings of the students of learning-set learning. For example, that which Harlow calls a "single problem" in learning-set learning, is not what the animal must learn in order for it to be described as having learned a learning set; rather, it amounts only to a single step taken on a long path; to the accomplishment of one phase in the larger situation wherein restricted practice is given on a long series of problems (or sub-problems). The problem the animal must solve before it has learned a learning set, is the problem of learning the criterial attributes common to all members of the set or category the experimenter happened to define in the beginning.

Certainly there is no objection to Harlow's description of matters along lines such as those indicated above. On the other hand, by applying the same reasoning, one can say that each run--or pair or trio or sextet (etc.) of runs--of a rat in a maze is perfectly analogous to the situation wherein practice is given on a "single" problem in the Harlow paradigm. If the problem is learning a T-maze, that which is involved in each run--or pair or trio or sextet of runs--varies very little from run to run (or from pair of runs to pair of runs, etc.). If the maze is more complicated, this variability increases. In a very complicated maze, that which would be learned on the first run (or pair or trio or sextet of runs), would be quite different from that which would be learned on the 100th run (or the 100th pair or the 100th trio or the 100th sextet, etc.) If each run (or pair or trio or sextet of runs) is to be regarded as a "single problem," it would have to be assumed that the animal learned something in each defined instance, and that this learning would sometimes transfer and facilitate learning at a later point. Following our arbitrary definition of "a single problem," we would have to call this a case of inter-problem transfer. But, obviously, it could just as reasonably be thought of the other way: as being a matter of intra-problem transfer. This seeming difficulty, it seems to me, is a matter only of definition: of definition of "single problem."

The main point for present purposes is only this: whenever a "single" problem becomes complicated in the sense that it is comprised of several or many elements, it may be misleading to regard it as a single problem if one is thinking along a line wherein it is useful to compare learning-set learning with "single-problem" learning. That which learning-set learning is, indubitably, is complex. And complex learning correlates more highly than simple learning with phylogenetic rank (and, of course, with developmental level). Perhaps only this last conclusion should be inferred from learning-set studies.5

5.1.2.1 The grand learning set. Harlow (1959) expresses the view that concept formation is learning-set learning; that an animal must have had a history of having solved similar problems if it solves a particular problem "insightfully." In Hebb's (1949) view, though, there are no clearly justifiable criteria for labeling one kind of learning "insightful," and other kinds, "not insightful." Rather, it seems more defensible to speak of degree of insight. If one has no clear basis for speaking of differing degrees of similarity between a present problem and problems previously solved, Harlow's view may be valid, even necessary; but it is a view that seems too generally valid to be provocative.

There is a question, too, about the notion of "concept formation." Speaking of concept formation only in passing, Harlow says this: "Broad stimulus generalization, which is what we call concept formation, was obtained only after extensive training on a wide range of problems of a class. . . ." (1959, p. 511). It seems to me that "broad stimulus generalization" is quite precisely what concept formation is not. (This is considered further in 5.2.4.)

On another point, Harlow offers the following as a speculation. "In view of modern genetic theory, which holds that evolution takes place by the selection of multiple small mutations, it is not unreasonable to hypothesize that the fundamental process of learning has probably remained essentially unchanged for near-countless millions of years. Furthermore, there is nothing relating to the slow, but progressive, evolution of the nervous system to suggest any great master mutation giving rise to a new learning mechanism" (1959, p. 531).

Harlow could not have known it when he wrote the above, but there is reason to believe that selection has progressed, at "moments" in time, by rapid spurts: and that a "great master mutation" may indeed have "given rise to a new learning mechanism." The evidence now seems clear that tools made possible a way of life such that the pressures operating in natural selection were quite drastically changed. Washburn (1960) reviews this evidence which indicates that contrary to previous views man did not slowly evolve to his present structural state (including a big brain), and then acquire tools, language, and a complex culture; but, rather, that pre-human primates began using (unsharped) stone tools, and that this is what lead to the selection of large-brained fully bipedal near-man, then man.

The tools that have been found together with near-man are described by Washburn as "mere pebbles." And although they were unshaped, their utility relative to the bare hand (so far as bashing in the heads of an enemy or digging roots are concerned) must have been immense. This use of pebble tools is now believed not only to have selected out big brains, but also to have changed patterns of child care, the nature of the sex drive, and to have determined a basic form of social organization (Washburn, 1960).

The brain size of the first tool users is now known to have been approximately that of present day apes. It evolved rapidly to double this size, and thereafter a little more slowly, to triple size. The big brain created some difficulties, though, that affected the mother-child relationship. Apparently bipedalism had the effect of decreasing the size of the bony birth canal, and at just the time tool-use was selecting out big brains. This pressure selected out near-man primates that gave birth early (to get the head through the canal before it was too late). This, in turn, required a long period of infancy in which the mother had to attend to the child, often immobilizing her as a food gatherer. These conditions operated to select out animals that employed a social pattern of a sort where mother and child would be cared for by the food-hunting father. This last was facilitated by a changed sex drive. The year-round sexual activity, limited to monkeys and apes, was further changed by this last selection force in a manner to remove most fluctuating hormonal controls, making possible a continuing bond of sexual attraction with the result that the female became continually "useful" to the male.

This evidence is possibly supportive of the idea that present day man has more, or (in some way) different kinds of learning sets than does not-man. It would seem to me to be a possibility that man acquires quite a few learning sets, but, perhaps, not more than a well trained monkey; though in addition, that man has a learning set of learning sets, a grand learning set.[6] Indeed, he has a technology in quite the same sense as was the pebble tool, he has a grammar.[7]

5.1.3 Language as a Syntactical System. A grammar includes, prominently, syntax. A representational system cannot usefully be conceived of as a language, unless it has a finite set of symbols and a set of rules for generating an infinite number of assertions. Indeed, English has no longest sentence (Chomsky, 1962).

The subject of syntax has arisen at several points in this monograph. It is an important topic. Our interest at this point is two-fold. First, is the contingency learning that is demonstrated in learning-set studies, in any way akin to syntax? (That is, can animals be taught "syntactical" rules?) Second, how does the child learn syntactical rules?

It is generally said that the requirement of syntax is not met in any known animal communication system. "Duality of patterning," of which one aspect is syntax, is claimed by Hockett (1960) only for language, hence man. Hebb and Thompson (1954) also believe the presence or absence of a syntax is *perfectly* criterial for separating the language system of communication of men from the communication of all other animals.

But even granting that this is so, it might be possible for man to teach a syntactical system to an animal; and perhaps complex contingency learning in animals, as is so clearly evident in learning-set learning, is an example.

5.1.3.1 Other data. Studies of animal learning that give evidence of contingent behavior are quite numerous. From Pavlov's laboratory came early evidence that dogs can learn to respond differentially to different sequences of the same set of tones. Razran (1939) has reported later experiments by Russian psychologists that confirm this. Lashley (1938) has reported something similar in what he calls condition*al* reaction (in rats): a phenomenon remindful of Harlow's (1959) discovery. However, Lashley (1961) has since discussed "the problem of serial order in behavior" in a way to convincingly rule out associative chain (and other, related) theories.

In the classical Kellogg study (Kellogg & Kellogg, 1933), the husband and wife authors raised a female chimpanzee as a sister to their own (biological) son. The Kellogg's "adopted" their chimp, Gua, at age seven and one-half months, when their own son, Donald, was nine and one-half months. For the next nine months the Kelloggs attempted in every way they could to raise Gua just like they raised

Donald. A most interesting question, of course, was whether or not Gua might learn to "understand" and produce speech. The answer appeared to be affirmative as regards "understanding," though negative as regards the production of speech. Gua vocalized, but these seemed to be expressive cries.

At the end of the nine month period, Gua and Donald were close in ability in one respect but not so close in another. Thus Gua "understood" almost as many individual utterances as Donald; but Donald was just beginning to respond appropriately to new combinations of already familiar words on first utterance, while Gua could not.

Brown (1958) summarizes the Kellogg and Kellogg study, and also the more recent and more careful replication of it by Hayes (1951), along the following lines. What is involved here, Brown believes, is not so much the matter of the number of signs to which an animal can be taught appropriate responses, nor the complexity of the responses, but the animal's inability "to produce systematic novelties" (p. 182) by combining signs in novel ways, or to interpret novel combinations upon first encounter. The contingency learning of animals--for example as shown by Lashley's (1938) rats or Harlow's (1958) primates--is indeed a little like the way syntax functions in language. The animal, in effect, learns the idea "do not do A if B is present." Do not remove the right-hand object from the food tray if the tray is a certain color (as in the Harlow paradigm); or do not approach the upright triangle unless it appears against a plain background (as in the Lashley paradigm). But, of course, the animal's negation in all reported instances, is a negation in a specific instance and as regards specifically practiced responses. Further, it generalizes (in the sense of stimulus generalization) to a narrow category of similar problem situations. The negation of language, on the other hand, can be made to apply to any act at all. But though the gap is wide, it still might be argued that the difference is explainable in quantitative terms. My own bias is that a qualitative difference is involved.[8]

5.2 Some Ontogenetic Considerations

A remarkable thing about language learning is that present day learning theories can explain much of what happens up until about age two, at which time the facts at hand do not fit so well. There are difficulties with "reinforcement" explanations beginning with the child's earliest learning; but after age two, the situation becomes much more difficult to account for. It is beginning to appear that childhood development in thought and language has noticeable discontinuity (Bruner, 1963, 1964; Church, 1961; Vygotsky, 1962).

5.2.1 Types of Generalization Continua. We take note of this because the experimental work supporting this thinking has consequences for instructional practices that involve the use of iconic symbols. What I attempt to do in 5.2.1, is discuss certain interrelated "generalization continua" that we need to know about for a later purpose,

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and to relate some of these to child development. We begin by noting a few things about learning.

5.2.1.1 Primary and Secondary Generalization. In a conditioning paradigm an animal learns a certain response to a certain stimulus. After this, other previously ineffectual stimuli will now evoke this response even though the animal has received no training involving these stimuli. Thus a goat trained to bleat to middle C played on a violin at a certain loudness, will also bleat to violin tones of slightly different frequency or loudness, or to the different timbre of middle C on a flute. The more these latter stimuli differ from the stimulus on which training was given, the weaker is the response that is evoked. This illustrates "primary stimulus generalization."

When first observed in early studies of classical conditioning, this phenomenon quite understandably looked like what had always gone by the name of "generalization," and so it was thus regarded and thus named. But the various stimuli that evoke a common response in stimulus generalization, are stimuli that vary from one another in minimal ways, and this suggests that this sort of "generalization" results from a failure to discriminate (E. Gibson, 1959). At least it represents a tendency that decreases with increasing learning. Thus the "generalizing" goat of the preceding example can, through additional training, be taught to bleat less promiscuously than originally, by rewarding only the bleating responses that are made on middle C to a violin.

It does not seem appropriate to regard primary generalization as similar in any meaningful way to what, traditionally, has been intended by the concept, generalization. "Generalization," in the sense of primary generalization is what characterizes the behavior of the young or untutored; and on one level, at least, the process of learning can usefully be thought of as learning to attend to differences previously ignored: that is, to develop in a direction *opposite* that of primary generalization. But whatever the precise interpretation one wishes to make, there is very little doubt but that two distinctively different phenomena have come to share a common label, "generalization."

Primary generalization is readily observable in early language learning. For instance, it has been often observed that at a certain age, all adult males are "daddies." And a young child who has learned, say, the name "rabbit" for his pet, will bestow this name not only upon other rabbits, but also upon cats and dogs and similar little animals, though not snakes, snails, trees or fleas. Hochberg and Brooks (1962), for example, report that a child raised in a pictureless environment for his first 19 months of life, at that age saw a picture of a horse on a television screen, and excitedly cried "dog." A parent or other will correct such mis-labeling whenever it is observed, and the child will in time come to apply a particular name less generously.

To illustrate further, let us imagine that a parent wished to teach the word "red" to his young son. The parent might find a red fire engine, let us say, and point to this object while reciting the word "red." If this were done repeatedly the child would, in time, associate the word "red" with this particular *object*, the fire engine. The child might also respond with the same label to different but "similar" objects. But then a question arises: similar in what way; similar as regards color, or similar as regards something else? There would be no assurance that the quality of redness of the original stimulus object was the quality that would account for any observed stimulus generalization. Indeed, the probability of this happening would be low. It is not likely that such a procedure would insure the child's learning to associate the word "red" with that particular attribute (that is, of *redness*, apart from any particular object), because it is not possible by pointing or gesturing to unambiguously direct someone's attention to specific attributes of objects. Lacking language, it is only possible, at best, to direct another's attention to objects.

Of course in the usual situation, the child would hear the word "red" in association with red balls, red bugs, red fire engines, red roses, red paint, red crayons, and many other red things. In time, the child would come to be able to label the single attribute that was common to every member of this diverse collection: the attribute, redness. And he would then be able to recognize this quality in other objects never before seen. This notion of redness is a generalization in the second meaning of that word: it is an instance of "secondary generalization," and it is what we shall refer to as a "perceptual concept" (5.2.1.2).

Primary generalization may occur in the absence of conceptualization while the very notion of secondary generalization implies that conceptualization was involved. (This is why I earlier expressed dissatisfaction with Harlow's interpretation of the notion, "concept"; for he spoke of concept formation as being dependent upon "broad stimulus generalization." Secondary generalization results from the often discussed process of "abstracting out" or of paying attention to common attributes shared by some of the elements of a collection, and then "generalizing about" these commonalities. In brief, secondary generalization is what is ordinarily intended by the unmodified use of that term.

5.2.1.2 Perceptual and Conceptual Categories. In general, children learn the names both of objects (cup, chair) and of actions (run, play) before they learn the names of attributes of objects (round, red). This might suggest that the ability to discriminate between attributes of objects comes relatively late, but the opposite is the case. Some examples given by Church (1961) will illustrate this.

Church reports that an eighteen-month-old child labeled all red motor vehicles with the name, fire engine. Red-colored vehicles ranging from sports cars to trailer trucks were, one and all, so named. This child did not refer to telephone or power company trucks as fire engines, even though these latter carried extension ladders and other fire-engine-like paraphernalia. From what has been said, one would thus guess that "redness" was highly criterial for whatever category it was the child labeled as "fire engine." It may seem something of a surprise, then, to learn that this child could not be taught, even with "considerable instruction" (Church's phrase), to reliably distinguish a patch of red color from other color patches.

However, children younger than age two do respond to formal attributes of objects such as shape, color, texture, etc. A baby of only a few months age, if fed his normal formula and a salty formula from bottles differing only in color, quickly learns the needed color discrimination (Church, 1961). Even so, it is not until quite a few months later that color, as an attribute separable from objects, has demonstrable significance for the child (e.g. color, as separable from the nursing bottles in which the discriminated colors inhered in the original learning).

Children before age two do have some names for attributes of objects, but these seem to be limited to the more immediate or tactual attributes like hot-cold, hard-soft, rough-smooth. The young child has names of shapes in the case where the object is named after its shape--as star, or triangle--but he cannot describe the shape of so familiar an object as a ball or block, nor fit such forms into a form board; though he can draw certain of these forms if asked to draw an object that happens to have the form asked for. That is, he cannot draw a circle if asked for a circle, for the abstract notion of "circleness" is not acquired until some time later. But he can often draw a fairly good circle if asked, say, to draw a ball. Apparently, the child has the global concept "ball," including "circleness," but he "has" this attribute only as an inextricable feature of the whole ball (reported by Church, 1961). This global manner of perceiving has been referred to as "physiognomic perception" (5.2.1.4.1).

Perhaps most interesting of all, in terms of a theoretical stand recently taken by Bruner (1964), and described at a later point in this chapter (5.3.2), is Church's observation that toddlers and young pre-school-age children, in copying a parent's drawing, try to reproduce the parent's arm movements rather than the visual form of the drawing represented on the paper.

5.2.1.3 Generalization and Attribute Immediacy. When a young child has learned to properly apply the names of formal attributes like color names, names of shapes, etc., and to do this independently of the objects in which these attributes inhere, he can be said to have formed a category; but more particularly, a "perceptual category" (Bruner, Goodnow & Austin, 1956). True, or secondary, generalization (as opposed to primary generalization) is implied by such a category. But what I shall call a "true *concept*," after Vygotsky (1962)--and by this I mean a conceptual, as opposed to a perceptual, category--is not implied. To anticipate a bit, evidence will be presented which suggests that language may be necessary for the formation of "true concepts" (i.e., conceptual categories), though not for concepts of the sort identified here as "perceptual categories." This distinction seems useful because of this: that while there are obvious and important differences between primary and secondary generalization, there are also differences of a mighty magnitude within the range of secondary generalization (between concepts based on generalizations about attributes such as color, for example, and concepts like "truth," or "syntax"); and we want to recognize this last difference and commemorate it by naming what is distinguished.

In Figure 5.1 are presented some "generalization continua" displayed so as to show some similarities and differences between several related ideas. The top line of the figure (Roman I) represents the already discussed and fundamental distinction between primary and secondary generalization. Two different continua are shown, to indicate that these are different (indeed, opposed) processes.

The second line of Figure 5.1 (Roman II) puts the matter in terms of the types of categories that we shall find it useful to label. No categories are listed under "primary generalization," for conceptual processes are not thought to be involved. Perceptual and identity categories are roughly paired on this continuum, as are conceptual and equivalence categories. A genuine continuum is intended as regards the perceptual/conceptual distinction, though the illustration is purposely left ambiguous as regards the identity/equivalence distinction. (Though it does seem that there is a fairly sharp break, phenomenologically speaking, between identity and equivalence categories.)

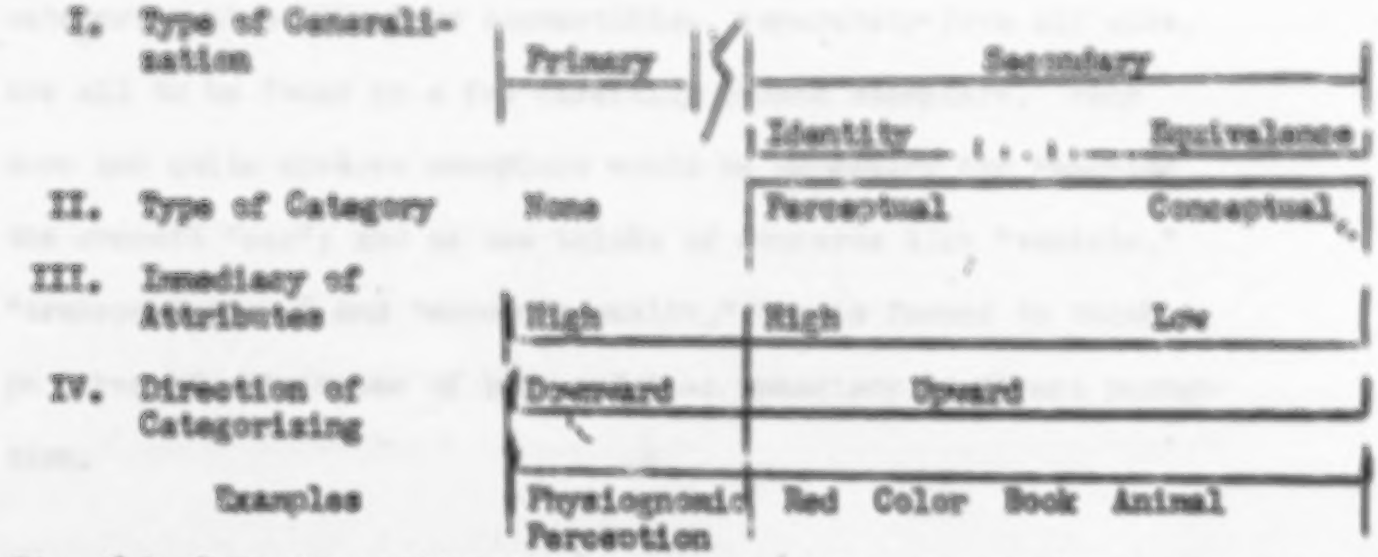

Fig. 5.1--Some "generalization continua" showing the similar nature of several notions.

To illustrate: A particular blue 1961 Ford convertible can be thought either to comprise an identity category, or to be a member of any one of several equivalence categories. It would comprise an identity category if, through constant acquaintance, the admiring owner was able to separate his from all other Fords, including all other blue 1961 Ford convertibles. At the same time, this identity category is, as well, a perceptual category; but for most people, any given blue 1961 Ford convertible would be regarded as a particular instance of an equivalence category. Still (and no less), it would remain a perceptual category.[9]

This distinction between perceptual and conceptual categories is explained by Bruner et al. (1956) in terms of the immediacy of experience of the attributes upon which the categorizing depends. This is represented as Roman III in Figure 5.1. If the attributes with which one is concerned are immediately at hand for direct perceptual exploration, the category thereby formed is perceptual. The transition from perceptual to conceptual categories is gradual. The attributes it is necessary to learn in order to be able to categorize blue 1961 Ford convertibles, separately from all else, are all to be found in a few carefully chosen exemplars. Many more and quite diverse exemplars would be necessary for teaching the concept "car"; and as one thinks of concepts like "vehicle," "transportation," and "economic wealth," one is forced to think in terms of attributes of less and less immediacy to direct perception.

5.2.1.4 Upward and Downward Categorizing Processes. Church (1961) has called attention to a widely ignored distinction helpful for category metalanguage: that between "upward" and "downward" categorization (Roman IV, Figure 5.1). As already noted, the child's earliest categories are vague and broad. Thus "fire engine" designated all red motor vehicles for the child of an earlier illustration. (This child had "overgeneralized," though only in the sense of stimulus generalization.) That which is required of a child, in such a case, is that he learn additional distinctions, that he learn to attend to previously ignored attributes.

Downward categorization is quite a different matter than the upward categorization involved, say, in science; where one searches for commonalities in seemingly diverse phenomena so as to account for the widest possible range of phenomena with the smallest possible number of theoretically-linked empirical sentences.

What it is important to note, I think, is that considerable learning experience of a downward categorizing sort is a necessary prerequisite to the later achievement of the more difficult upward categorizing problem solutions. This is because an "upward categorizing" problem first requires the ability to categorize any given collection one way one instant, then to immediately recategorize this same collection along different lines an instant later, and to be able to do this repeatedly and with speed as different problems emerge, or as different considerations are brought to bear. The greater the downward categorizing experience a learner has had, the greater is the number of potentially criterial attributes that he has at hand with which to form any of a large range of categories (from any given collection), as different problem-solving needs arise.

5.2.1.1.1 Physiognomic perception. Before the child has developed to the point that he can categorize "upward," he has first to have had a lot of "downward" categorizing experience. For a child lacking such experience, it seems likely that any behavior seemingly reflective of the possession of broad (general) categories is, rather, evidence that the child is perceiving physiognomically.

Heinz Werner was the *first* to use the term "physiognomic perception." According to Werner, this type of perception "reveals a relatively limited differentiation of object and subject, of perception and pure feeling, of idea and action etc." (1940, p. 59). This object/subject unity results in a "dynamization" of the objects of perception: a landscape is seen as gay, a color as warm or soft.

The tendency to perceive physiognomically is supposed to be especially strong in young children, though existent in some degree at all ages. Inanimate as well as animate objects are seen in a global, undifferentiated way, as having "physiognomic meaning-qualities." This contrasts with the usual adult description of objects in terms of the formal attributes of the object (such as size, shape, color, texture, etc.).

Despite a certain imprecision in the concept of physiognomic perception,[10] there are enough instances of the phenomena, and these have been often enough observed, that they merit credibility.

They also merit our attention because phenomena such as described by Church--for example, the case of the young child who called all red-colored vehicles, fire engines--seem likely to be instances of physiognomic perception.

5.2.2 Language Learning. I have spoken just a little about the child's acquisition of those kinds of words called lexicators. However, the manner in which language is learned is not understood. There are difficulties even on the level of lexicator acquisition, and there are yet more subtle difficulties on the level of formator acquisition, or grammar. The character of some of these difficulties is becoming more clear, though, and I shall attempt to show this.

5.2.2.1 Learning words. It has been assumed that all infants babbled all the sounds of all the languages; that early babbling was random and unpatterned; and that through selective reinforcement the speech sounds of the particular language community into which the child was born were gradually selected out and retained.[11]

But this is not factual. Following Irwin (1949): Babbling is patterned and stereotyped; the initial repertory of sounds is small; and during the first few days of life, only eight distinguishable sounds are frequent (only a fifth of those needed for adult speech). The highly stereotyped nature of babbling is suggested by the fact that 90 percent of an infant's vowel utterances are the sound of the middle letter in "fat."

As age increases there is a highly regular increase in the number of phonemes used, not a reduction through "selecting out."

It is expressed as $N = 7.53A^{.471}$ where N stands for the number of different phonemes, and A for age (Irwin, 1949).[12] Finally, a "reinforcement" interpretation of learning requires the young child *gradually* to cease babbling as he begins to take up speech. But babbling and speaking are typically discontinuous: babbling ceases with the onset of speech (Church, 1961).

Another problem is one mentioned earlier for another reason: the well attested case of a child who had never spoken, yet learned to understand speech. Parallel to this is the fact that a child regularly understands a word before he can use it; and that the time lapse between demonstrated understanding and first use is often a matter of several weeks, and, sometimes, even months. Moreover, this discrepancy is regularly increased in *all* types of developmental speech disorders (Lenneberg, 1962). Perhaps Church is correct in saying that it "makes no better sense to say that speech is selectively reinforced babbling than that writing or drawing is selectively reinforced scribbling" (1961, p. 83).

5.2.2.2 Learning grammar. A truly most remarkable fact is one that may seem prosaic on its face. It is this: one child, at least, talks to himself when alone in his crib at night before going to sleep. This child (a boy two-and-a-half years of age) carries on monologues that sound as if he were reading the pages of a grammar book (R. Weir, 1962).[13]

The child was the son of the researcher, Ruth Weir, who recorded his speech by means of a microphone placed near his bed.

All the child's speech was recorded and given careful linguistic analysis. It might be expected that such speech would contain much gibberish, or involve rehearsing memorized monologues, be comprised of endless repetition, random utterances of one sort or another, or whatever. Anything at all might be expected, really, except what occurred: the child systematically drilled and corrected himself, he used fixed sentence frames; and, employing the small number of words of a two-and-a-half-year-old, he systematically practiced noun substitutions, noun phrase substitutions, adjective substitutions, and verb substitutions.

A psychologist (George Miller) and a linguist (Roman Jakobson) wrote separate forwards to Weir's book. Both expressed astonishment and delight. Jakobson commented that the child's speech bore a "striking resemblance" to the exercises that appear in self-instruction books in foreign languages.

Weir's effort represents the analysis of the speech of one subject in one type of situation extending over a period of only eighteen evenings. And yet the analysis required over 200 pages to report. One might suspect that the child's concern with language itself was transitory, that this was a unique case--though Bellugi reports other support (see footnote 13)--or that what was reported constituted only a small fraction of the total of the child's recorded speech. Apparently this last was not so; but repeated observations will be needed to test the generality of what was reported.

Brown and Bellugi (1964) report a longitudinal study (begun in October, 1962)[14] of the development of syntax in a boy (age 27 months at start of study) and a girl (age 18 months). These subjects were each visited every second week and all utterances of each, and of the mother, experimenters, etc. were recorded. These sessions were always at least two hours in length. A complete record of actions as well as speech was made.

Three processes in the language development of these children became apparent: (a) a process of "imitation and reduction," (b) "imitation with expansion," and (c) "induction of . . . latent structure" (Brown & Bellugi, 1964). Imitation with reduction describes what the child does when he tries to repeat a sentence of the parent (or other adult). In doing this the child always preserves the word order of the model sentence. He leaves words out, but never reverses the order of those he does use. Equally as regularly, that which he leaves out are "formators."[15] It will be recalled that these are words that do not name "things" but, rather, that indicate the way other words with which they are associated in a sentence are to be interpreted. They are articles, prepositions, inflections, conjunctions, and such: for example, "a," "the," "and," the progressive inflection "ing," and the possessive inflection "s," etc.

That which the child does not exclude are the lexicators: these are a category of words that include point-at-able objects as an important subcategory. These are the words the child learns early as single names.

Imitation with expansion describes the case wherein the child provides the model sentence and the parent (or other adult) imitates. (Brown and Bellugi discovered that adults (not just parents) do indeed imitate child speech, and quite frequently.) But the adult's imitation of the child is not a precise imitation. The adult does preserve the child's word order, but, in addition, the adult fits omitted formators into place around the child's lexicators.

That which a child does in reducing a model sentence by omitting formators, is to speak in the same telegraphic style an adult uses when words are at a premium as in cabled messages, newspaper headlines, etc.

Both of the children studied by Brown and Bellugi produced quite a large number of sentences no adult would be likely to have produced: for example; "My Cromer suitcase," "Two foot," "A bags," "A scissor," "A this truck," "You naughty are," "Put on it," "Put a gas in." (p. 144)

The authors point out that it is difficult to achieve grammaticalness in sentences of the above type simply by adding formators. It is therefore hard to imagine that such sentences as these are reductions of adult models. The authors believe they are not; rather, they believe that these sentences are mistakes of a sort that provide evidence of the child's search for grammatical regularities.

In the case where a child speaks grammatically (or ungrammatically in the way the adults about him speak), this fact can be taken to reflect imitation resulting because of selective reinforcement. It has long been observed, on the word construction level, that certain errors are logical: for example, "house" "houses"; hence, "mouse" "mouses." This is an overgeneralization of the inflection for forming plurals, interestingly externalized for view. The pre-school child is also able to do this sort of thing with nonsense words, thus demonstrating that he has learned morphological rules independently of their embodiment in particular words. For example, shown one picture of a bird-like animal, then two, the child is told: "This is a wug. . . .Now there is another one. There are two of them. There are two ______" (Berko, 1961, p. 362). The child supplies the answer, "wugs," in agreement with expectation (it being supposed he has learned the necessary morphological rule).

But syntactical overgeneralizations of a sort to account for the hundreds of sentences reported by Brown and Bellugi, are difficult if not impossible to find. In fine, it looks very much like something besides imitation with reduction (or expansion) is involved. Somehow, the child "induces" a "latent structure," as Brown and Bellugi phrase it.

Whatever the nature of this process may turn out to be, it is one that makes it possible for a child's language ability to rapidly outstrip that which can be accounted for by the experiences he acquires in imitation (or by "reinforcement"). It would be impossible to learn all the sentences one employs by means such as are implied in the first two processes described by Brown and Bellugi.

That a much more efficient type of learning must of necessity be involved, is evident also from calculations of a sort reported by Miller, Galanter and Pribram (1960). These authors show that a child (if he learned his language by learning left-to-right sentences) would have to hear, minimally, 2^{100} sentences. Assuming that he had to hear each sentence only once in order to retain it perfectly, he would have to hear 3×10^{20} sentences per second for 100 years, with no time out for eating or sleeping.

5.2.3 Review and Preview. Because of its essentially logical structure, language is an immensely useful technological device. In quite the same way the pebble tool gave near-man an immense advantage, resulting in the rapid selection of big brains, so too is language a tool of such importance. Both pebble and language are external to the organism; but their use changes their users. Indeed it now appears that man has been evolving by "prosthesis"[16] for a half-million years or so. That is to say, man has evolved for some time now, not by continued body or brain changes so much as by the use of external implements; meaning tools and including language as one of these. The pebble tool multiplied near-man's and man's physical power, while language multiplied his ratiocinative power (Bruner, 1964). Thus it may very well be that the child begins learning language in ways that seem quite familiar to us from our having observed animal learning; but that the beginnings of this acquisition change the manner of the acquisition. Later language learning might well be more efficient than early language learning for the most obvious of all possible reasons: the later learner has the beginnings of a technology for learning that the early learner lacks, and that technology is language. It is this sort of thought that Harlow's (1959) and others' work in learning-set learning suggests so naturally; and especially so, it seems to me, if one thinks of grammar as the "grand learning set."

That which it would seem important for the educator to realize, is that by whatever the means, the child just starting school has acquired a set of logical rules and that these are extremely important for transforming sensory information. From the point of view of the student of pictures, it is important to realize that these rules for transforming experience are especially useful in helping the child distinguish between "appearances" and "reality"; for as we shall see in following pages, appearances frequently mislead the child in cases where language could keep him straight.

5.3 Concept Attainment

American psychologists are at last paying attention to some extremely insightful if statistically unsophisticated work of European psychologists. One such is Lev Vygotsky, and the work he and his students have done concerning concept attainment in children, has been brilliant.

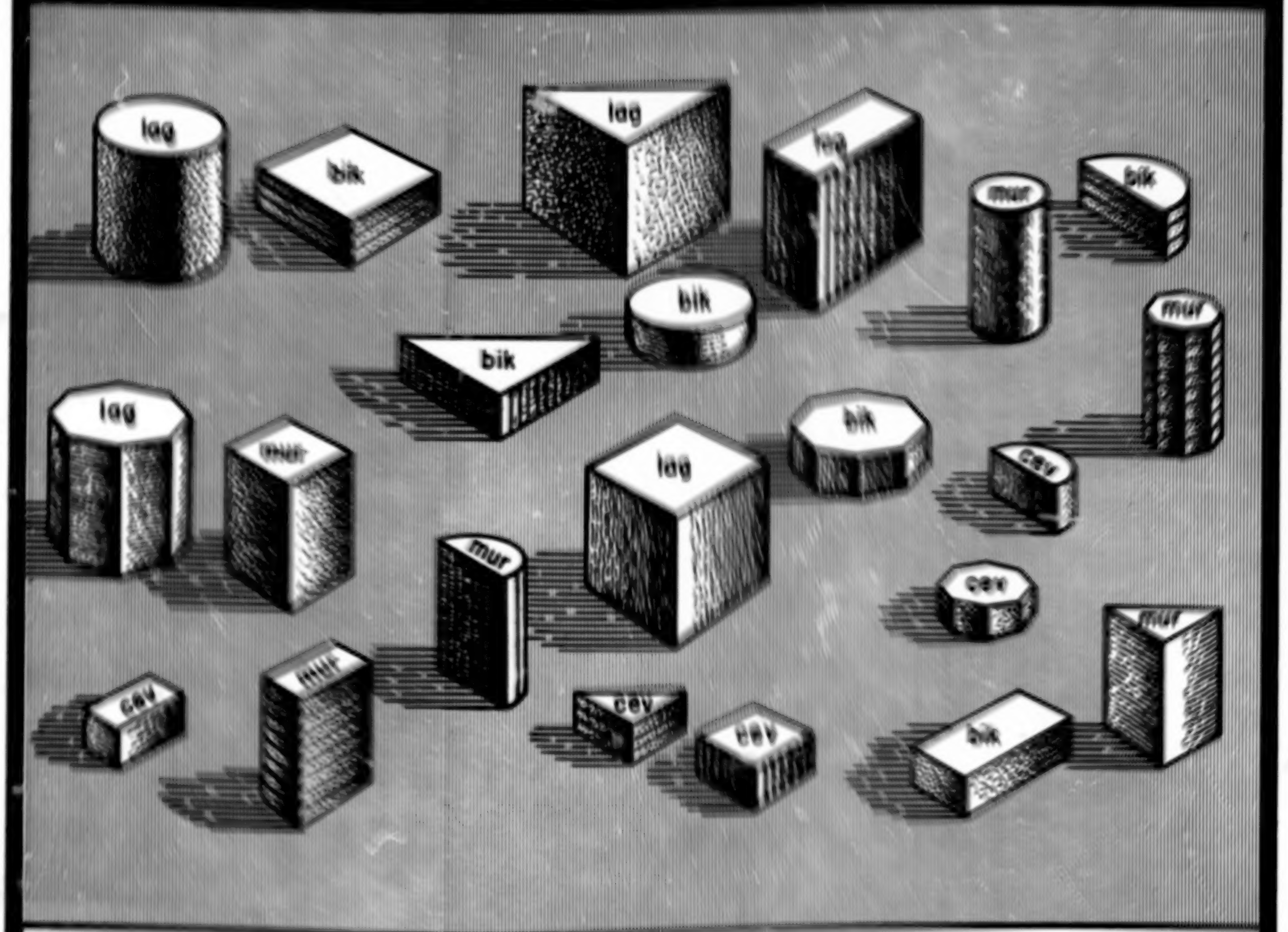

FIGURE 5.2 The Vygotsky blocks: a test for studying the process of concept attainment.

5.3.1 Vygotsky's Work. To understand Vygotsky's (1962) description, it is necessary to understand his test instrument. The materials are 22 wooden blocks of the approximate size and shape illustrated in Figure 5.2. They vary in color (indicated in Figure 5.2 by textural differences), shape, height and horizontal area. There are 6 shapes, 5 colors, 2 heights (tall and short) and 2 areas (large and small). One of four nonsense names--lag, bik, mur, or cev--is printed on the underside of each block. The blocks are presented in a mixed arrangement with the nonsense names hidden. The experimenter turns up one of the blocks, revealing the name to the subject. The experimenter then asks the subject to pick out other blocks the subject believes to have the same name as the sample block.

For example, the experimenter might turn up the round log-shaped block, labeled lag (Figure 5.2). Let us say that the subject guesses "roundness" is an attribute of lags, and gathers all the round blocks together in a group. There are two such in addition to the sample block, but neither of these is a lag. The experimenter then turns up one or the other of the two incorrect blocks (e.g. bik), and shows the subject his "error." The experimenter then instructs the subject to try again. With each failure another "incorrect" block is turned up to reveal its name, and the subject is asked to try again.

It can be seen (Figure 5.2) that four concepts are involved; and so any of the attributes, taken singly, is insufficient. For, as noted, there are 6 shapes, 5 colors (textures), 2 heights, and 2 (horizontal) areas. Taken singly, these would lead to 6, 5, 2 and 2 categories. It is therefore necessary to define each of the four concepts by the *joint* presence of two attributes. Thus the successful subject, after several false starts, will realise that all *lags* are tall, and also large; *murs* are tall and small, etc.

Vygotsky's studies led him to posit distinctive multi-step phases in the development of the ability to form "true" concepts. The first phase is one in which the child forms *heaps*. Given a sample block from the Vygotsky assortment, the very young child heaps other blocks together with it in trial-and-error fashion, or he may capitalise upon accidents of spatial localisation, grouping according to the distances separating the blocks (pulling the near together, etc.).

In the second phase the child groups blocks in one or another of five "complexes": associative, collective, chain, diffuse, pseudo-conceptual. The *associative complex* is seen when the experimenter turns up a block, and the child first adds a block that is similar to the sample in color, but then adds a block similar to the sample in shape. Each separate addition is in terms of some attribute held in common with the sample block, but this attribute changes with each block that is added.

In forming *collections* the child adds contrasting blocks to the sample block. If the sample were a blue block, the child might add all the yellow blocks, of if square, the round blocks, etc.

In chaining the child adds a second block to the first because, say, color is common; but the third block is added because, say, size is the same as the second block. Fourth block is like third in yet a different way, say shape.

A diffuse complex is one where, for example, the child adds trapezoidal-shaped objects to the original triangular-shaped object because (presumably) trapezoids remind him of triangles.

The last step in phase two is the pseudo-concept. The child groups the blocks in a way identical to the way he might have grouped them had a true concept been involved: for example, say the child puts all the yellow blocks together, thereby "implying" a concept of yellowness. Because of the way the test is constructed this is not a correct response, but a valid (perceptual) concept of yellowness could have been involved, and thereby have led the child to group the blocks as he did.

The experimenter's clue comes in the responses given by the child when the experimenter turns up one of the incorrect blocks for the child to see, and says: "This is not a cev" (or whatever). If the child has previously grouped on the basis of a valid concept (e.g. "yellowness"), he will see his error if told that one of the yellow blocks does not belong. However, if no valid concept (e.g. "yellowness") has been involved, the child may be quite ready to agree that the noted block does not belong, and may remove it, but he does not do anything else. He believes his grouping is now all right, the "erring block" having been removed.

Pseudo-categorizing is common in pre-school children. It often appears that a child and adult have formed similar or identical concepts because they use the same word to commonly name a few instances of a category (those that are around and at hand to be named). But if there were some way to get at the actual state of affairs, it would often be the case that although child and adult had a single word, this word commonly names for child and adult no more than these few instances. The adult's category is a true concept; the child's may not be. In fine, though the child's and adult's common words name common instances, these may not be instances of common categories.

To form a "complex" is to gather discrete elements together in a way to aid in making later generalization; and so is important developmentally. But it is not until the child can abstract out the common attributes in such a collection, and generalize about them independently of the particular objects in which they inhere (so as to correctly categorize new instances on first encounter), that a true concept can be said to exist. This, it seems, takes a longer time learning than has usually been supposed. Vygotsky found that the problem presented in his test procedure was unsolvable until about the age of twelve when the final, or concept-forming phase is reached.

Vygotsky is the Russian counterpart of Jean Piaget: similar interests and brilliance, and similar disinterest in detailed reporting of the experimental and other observational methods used. Thus the above description, unbuttressed, may seem insufficiently impressive. It is beginning to seem to be the case, though, that Vygotsky understood the child's processes of concept attainment better than anyone previous to his time. Bruner (1963, 1964) is one of those who have added credence, and also new dimensions to the discoveries of Vygotsky and his students.

5.3.2 Motor, Iconic, and Verbal Representation. On the basis of many studies, of which three will be described, Bruner has defined three ways of representing (and of processing) information. Representation through action or motor response is developmentally earliest. Many learned activities seem, almost, to be learned by the muscles: examples are walking, riding, skating, driving, typewriting. It is also through enactment that chimpanzees communicate with men as well as others of their kind. Relying on Koehler's work, Vygotsky (1962) describes how a chimpanzee will try to get another chimp to do something by beginning the movement he wants the other animal to perform, or sometimes by pushing; or by grabbing at the air when, for example, the first animal wants the second animal to give him a banana. Koehler came to use these same devices in his own communication with chimpanzees.

Developmentally, iconic representation follows motor or enactive representation. In this form of representation "images" (presumably visual in most cases) came to stand for perceptual events like a picture stands for its object (Bruner's analogy).

An instance is found in an adult given the task of learning a path through a complicated bank of toggle switches. He does not at first form an image of the path. But once the solution is greatly overlearned, he does form an image, and he comes to rely on it (Mandler, 1962; also cited by Bruner, 1964). For some types of tasks (at least initially) the adult as well as the young child seems to first rely on enactive representation, and later, upon iconic representation.

Last to emerge is verbal (or what Bruner calls "symbolic") representation. The design features of displacement, arbitrariness, discreteness, and duality of patterning (4.3.1) make this possible, and make possible an enormous gain in efficiency over iconic representation. This would seem to be due not so much to any increased "storage" facilities thus made possible (though there may be such an increase), as by the transformations of this information that are thus made possible.

5.3.2.1 Three studies. Young children of 4 or 5 years of age have no difficulty in gathering together the same-colored or same-shaped blocks under a certain instruction, but cannot form the needed conjunctive categories required for solution in the Vygotsky test until about 12 years of age. This last requires that the child be able to (a) abstract out the attribute of height (tall or short), (b) the attribute of (horizontal) size, and (c) to place these two attributes into the relationship patterns tall and broad, tall and narrow, short and broad, short and narrow. The (a) and (b) requirements are such that, taken singly, there could result the formation of a perceptual category. The "c" requirement, if met, results in the formation of a conceptual category. As adults we tend to think that we see such a relationship. Indeed, it is extremely difficult to regain our pre-conceptual naivete in these matters, but it is essential to do so in order to understand a limitation in the use of iconic representations in the instruction of young children. Bruner's and others' work (reported by Bruner 1963, 1964; but as of now, "in press") helps to this and other ends.

One of these "in press" studies was done by Bruner and Kenney (In Bruner, 1964). Theve investigators used a matrix (a flat surface with lines drawn to form a 3 x 3 grid) on which nine plastic glasses were arranged in a manner indicated in Figure 5.3. The subjects were children between 5 and 7 years of age.

The procedure was to seat the child before the matrix of plastic glasses, and then to familiarize him with this arrangement by removing, first one glass, then two, then three glasses; asking the child each time to replace them in their original position. The child was also asked to describe the glasses, telling how the glasses in a row and column were alike and different. After this the glasses were removed and scrambled and the child was asked to replace them the way they were. The glasses were then again removed and scrambled, and the glass that was in the lower-left corner was placed in the lower-right corner. The child was now asked to try and make something like what was there before, except that

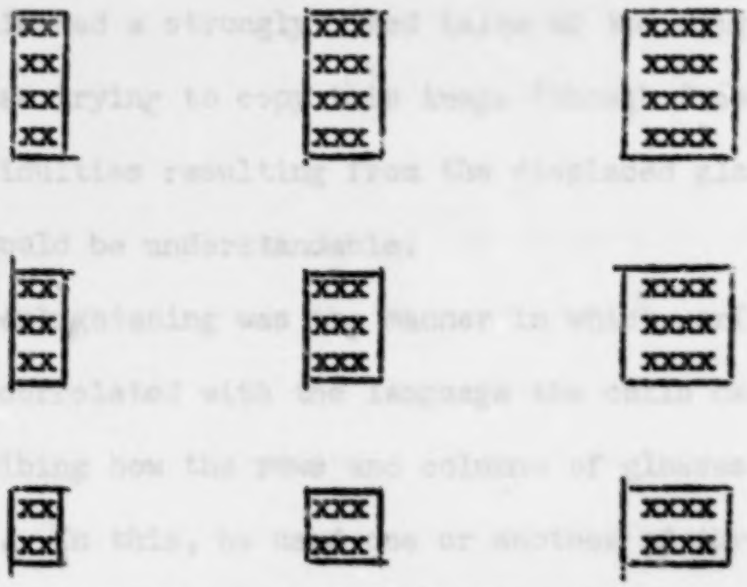

Fig. -- 5.3 The matrix of plastic glasses used by Bruner and Kenney to show the nature of the transition from iconic to verbal forms of representation.

he was to leave the one glass where the experimenter placed it. This requirement meant the child had to transpose the matrix.

All of the children could copy the original matrix. The older children differed only in being a little faster than the younger ones. But sharp differences did result when it came to constructing the transposed matrix. Nearly all the seven year olds but almost none of the five year olds succeeded in the transposition task.

The faulty strategy of the younger child was revealed by his manner of coping with the transposed-matrix problem. Sometimes he would move the displaced glass back to its original position; or he would rebuild the original matrix as well as he could in view of the re-positioned glass. Some children who tried this last, would put another glass right over the top of the displaced glass, and go on from there. If it were somehow possible to know that the young child had a strongly fixed image of the original matrix, and that he was trying to copy this image (though faced, as he was, with the difficulties resulting from the displaced glass), then his actions would be understandable.

Most enlightening was the manner in which performance on this problem correlated with the language the child had earlier used in describing how the rows and columns of glasses were alike and different. In this, he used one or another of three distinctive kinds of names of attributes. One of these was "dimensional." The child who described the glasses in dimensional terms spoke of two values of a single attribute: that is, the glass on one end was described, say, as tall; on the other, as short. Another type of description was "global." The child who used global terms would describe the glasses in a row (column) as differing, say, in "bigness" or in "littleness." In global language, a glass might be described as "big" either because it was tall or because it was wide. The children who used global descriptions would often apply terms like big (little) indifferently: that is, both in the case where the glasses differed in height but not width, or in width, but not height. The third type of description was one that confounded dimensional and global terms. The children who employed such language would thus describe one end of a row (column) with, say, the dimensional term "tall," and the other end with a global term "little."

The children who used confounded language (all ages lumped together) were twice as apt as the others to fail to solve the transposed-matrix problem; but whether or not a child used confounded language had no bearing at all on his ability to reconstruct the original matrix.

These results provide suggestive support for the validity of Bruner's distinction between iconic and verbal modes of representation. They suggest the manner in which the latter mode operates to aid in the transformation of information. It seems possible that the younger children (including those who use confounded language) depend more upon iconic imagery than do the older children (but including any of the younger who use dimensional language). Iconic imagery (assuming this turns out to be a descriptively accurate term) serves very well for tasks of recognition and reproduction; but, apparently, it serves not at all well when the need is to operate upon experience and transform it according to some rule.

An understanding of the next study requires an explanation of what is meant by "conservation." If a child between 4 and 6 years of age is shown two equally full, identically-shaped beakers of water, he will judge them as equally full. But if one of these beakers is then poured into a third that is either wider or thinner than the originals, he will no longer judge the two amounts of water to be the same. If the third beaker is thinner (increasing the height of the column of water) the child judges that this third beaker has the most water. If the third beaker is wider than the two originals (the column of water therefore being lower), the child judges the third beaker to contain less water than the original. In short, the young child cannot "conserve" amount under such a transformation.

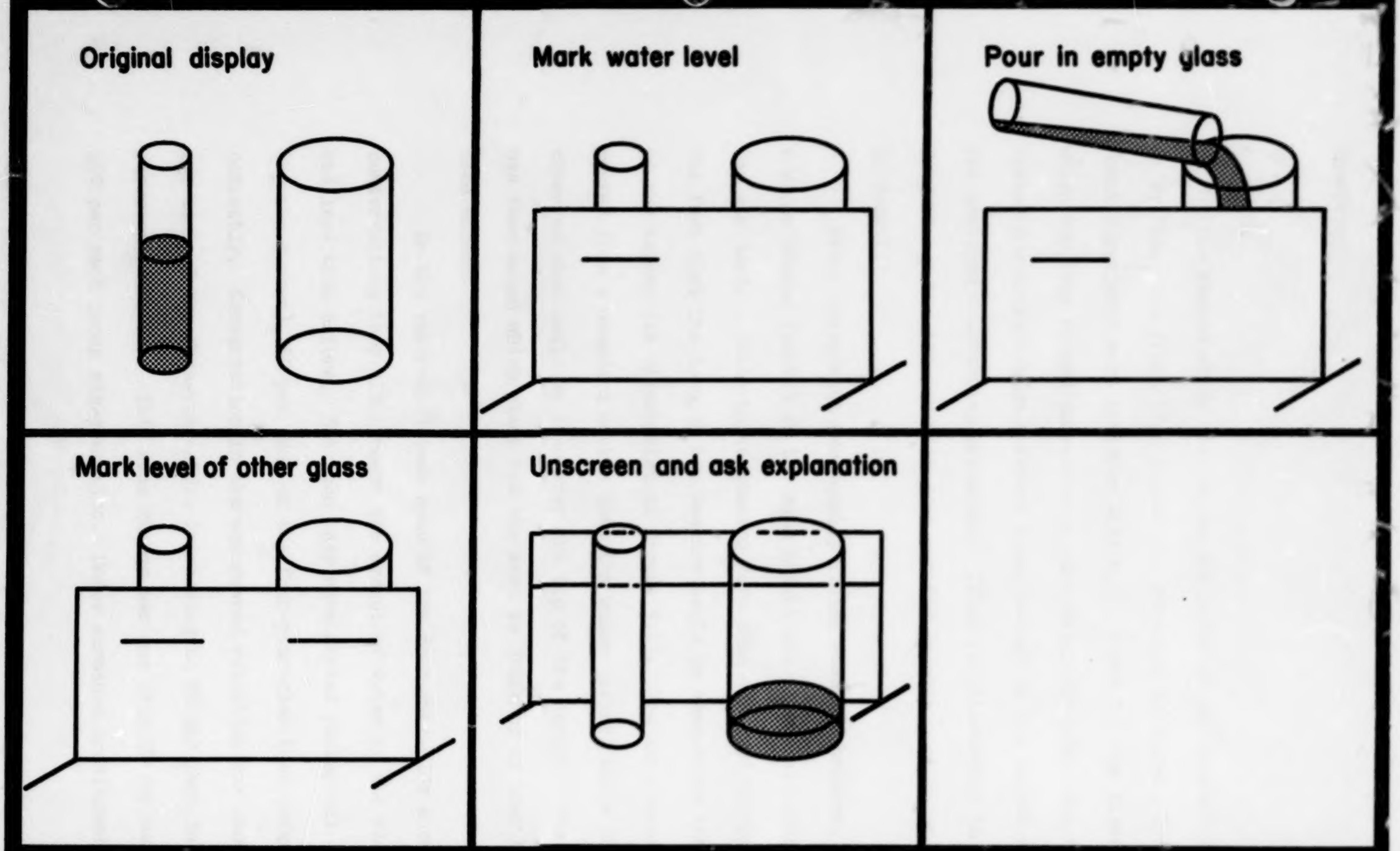

FIGURE 5.3 In a young child, a perceptual display can over-power the logic he has accrued through language. (Adapted from Bruner, 1964.)

The second study bearing on the point of our present concern is by Françoise Frank ("in press" but reported by Bruner, 1964). Frank's subjects were children ages 4, 5, 6 and 7. She first determined which subjects showed conservation, and which did not. She then tested for conservation a second time, though on the second determination she employed a screening procedure. (This is illustrated in Figure 5.4, though the illustration does not fit Frank's particular procedure in detail.)

Frank began with two equally filled standard beakers. Then a wider beaker (empty) of the same height was placed alongside the two standards. These three beakers were then screened except for the fact that the tops of the beakers could be seen above the top of the screen (as illustrated in Figure 5.4). The experimenter then poured from a standard beaker into the wider beaker, while the child observed what could be seen over the top of the screen. The child was then asked which glass had the most to drink or if they had the same amount.

In the unscreened test none of the four-year-olds showed conservation; they all thought the amount of water in the wider beaker was less than before. But when they were denied perceptual access (by the screen), 50 per cent of the four-year-olds then judged correctly. Conservation in the unscreened situation was shown by 20 per cent of the five-year-olds, increasing to 90 per cent in the screened condition. This same change was one from 50 per cent to 100 per cent among six-year-olds. Under screened conditions, the children justified their responses with statements like, "It's the same water," or, "You only poured it" (Bruner, 1964, p. 7).

Having made a judgment, the screen was removed, and the child expressed a second judgment. All the previously correct four-year-olds reversed their judgments. In other words when denied a visual display, half the four-year-olds could accurately employ the logic of their language ("It's the same water," as, see above); but when subjected to the visual display, they were one and all overwhelmed by it, and they reverted to a reporting of the way things "looked," not the way they "were." However, most of the five-year-olds and all of the six-year-olds and seven-year-olds stuck by their judgments. They explained this along these sorts of lines: "It looks like more to drink, but it is only the same because it is the same water and it was only poured from there to there" (Bruner quoting one of Frank's five-year-old subjects, p. 7).

The third experiment was another by Bruner and Kenney (again, "in press"; though described by Bruner, 1964). The subjects were children ages 5, 6 and 7. They were shown a pair of water glasses and asked which was "fullest" and which was "emptiest."

Let us begin by considering some typical answers given by these children. If the two glasses were identically shaped and equally full (either totally or fractionally), the older and younger children responded similarly and accurately in judgments of "fullest" or "emptiest." If, however, the glasses were of unequal volume, though equally but fractionally (say half) full, the younger children would judge the largest glass to be fullest and the smallest glass, emptiest. These were erroneous judgments, to be sure, for the two glasses were equally full, but at least they were logically consistent judgments.

The somewhat older children also responded erroneously in this situation, but in addition, they responded in a logically contradictory way. They said that the bigger of the two glasses was fullest (as the younger children did), but they also said that this same largest glass was also emptiest. This particular logically-contradictory error increased systematically with age.

In pursuit of an answer to this paradox, Bruner and Kenney asked their subjects whether the same glass could be both fullest and emptiest at the same time. The responses of both the younger and older children indicated that they thought the experimenters were playing a game of riddles with them.

The experimenters were able to resolve the paradox by selecting pairs of glasses with (as Bruner notes) a certain malice aforethought. Eleven pairs, fitting one or another of four general types, were chosen. In one type, glasses of unequal volume are equally and fractionally full (as in the illustration in Figure 5.4). In another, glasses of unequal volume are again used, though this time, they are completely full. In a third type, the glasses are again of unequal volume, one being filled, the other partly filled. In the fourth type, the pairs of glasses are identical: in some of the type four cases these are equally filled; in others they are unequally filled.

In asking 5 to 7 year-olds which glass of a pair was fullest and which emptiest in the several kinds of cases described, it became evident that the younger children were able to pay attention to but one attribute at a time. When one attribute was attended to, it was height of column of water (when this varied). Thus, as in the case illustrated in Figure 5.4, the fullest glass was the left-hand glass because the column of water was highest. For the younger subjects, the right-hand glass was emptiest, because height of column was less. When the height of the water column was identical in the compared beakers, the "one-attribute" children would judge the widest diameter glass to be largest. If both height of water column and width of glass were the same in the two compared glasses, though with one of the glasses being taller than the other, then the taller glass was judged to have the most water.

In brief, the judgments of the younger children are based on a global impression of apparent water volume, and this in turn is based on a single attribute of several possible attributes. Of the several possibilities, the preference is first for height of water column, then, width of water column, then height of glass.

What is it that happens, then to cause the children, as they get older, to begin to make an error not previously made? Using the same simple questioning procedures, Bruner and Kenney discovered findings illustrated in Figure 5.5. As the child approaches the age of six, he begins to pay attention to two attributes at one time. He judges "fullness" as does the five-year-old, but he also begins

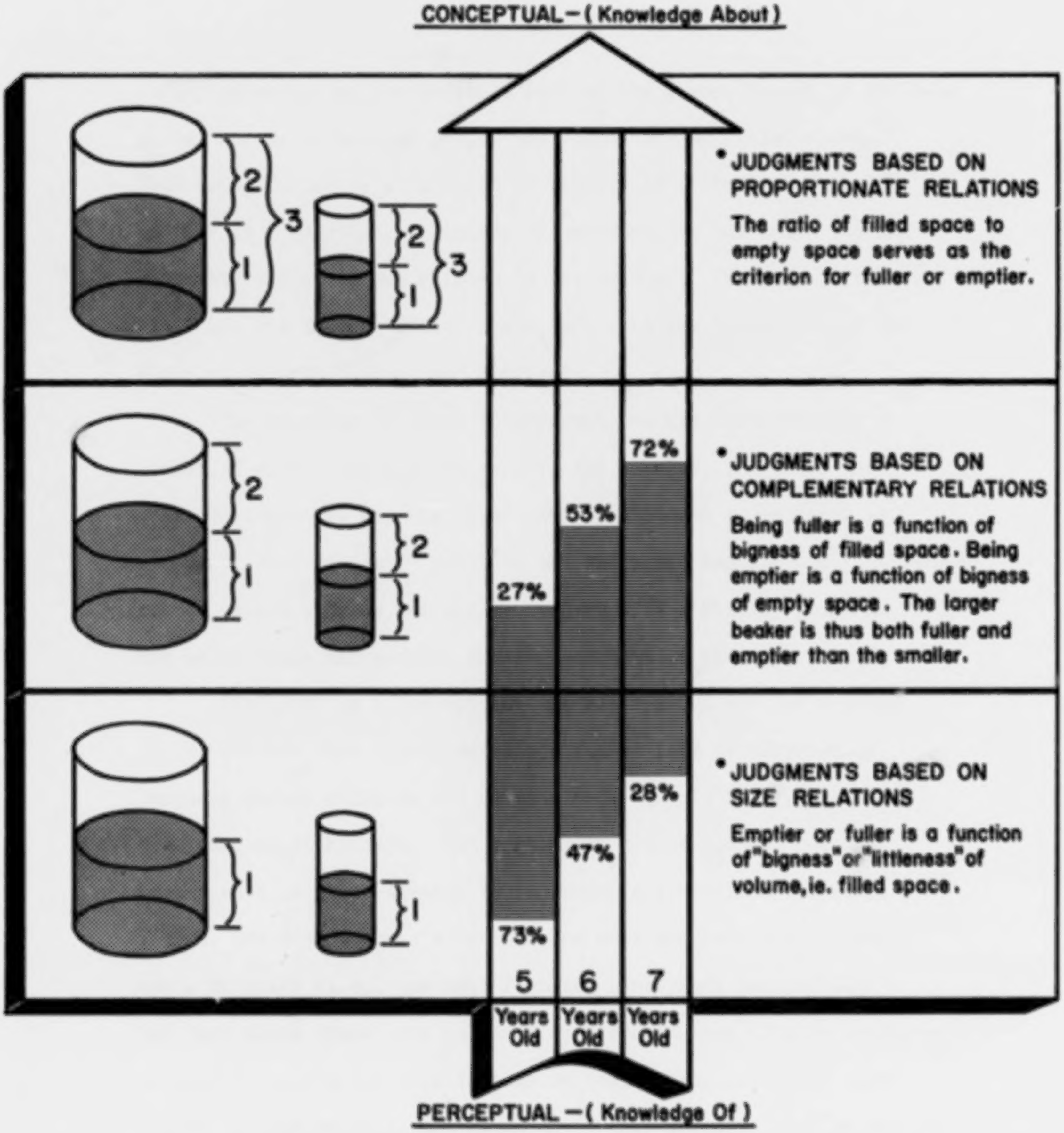

FIGURE 5.4 The number of attributes a child can attend to, as a function of age. (Based on findings of Bruner, 1964.)

to pay attention to the unfilled part of the glass, though in the same global way as he earlier judged the volume of the filled space. Thus being fuller is a function of bigness of filled space; being emptier is a function of bigness of empty space; but these two considerations are not yet related to one another. Thus the left-hand glass has the largest filled space, and also the largest empty space, hence it is both fullest and emptiest.

The accuracy of these interpretations was mainfested in a number of ways. The authors report, for example, that when the younger children are asked why the glass they have chosen as emptiest is emptiest, they typically point to the water and mention the "littleness" of the water; whereas the older children will typically point to the empty space and comment on the largeness of the empty space.

"Fullest" is a concept that is quite difficult for a young child, and one that likely demands a fairly full development of language before solution can be attained. Iconic imagery is of no help; indeed it hinders. The problem is one of somehow getting beyond what is point-at-able by employing a symbolic operation. Indeed, one must compute a ratio. One must abstract out at least two attributes (i.e., one must form two perceptual categories), and then place these into relation with one another (form a conceptual category). Achieving this last leads temporarily into what seems a more serious error in the older child than any such that is obvious in the younger child. The young child, moreover, sometimes gives external evidence indicative, on its face, that he has achieved a true concept. But this is seen in the Bruner-Kenney study to be a pseudo-concept of the sort Vygotsky (1962) described.

5.3.3 Implications for the Student of Pictures. The student of pictures has often urged that pictorial illustrations are important in instruction because pictures have the potential for reducing "verbalism." But pictures are post-linguistic, or if not, and if they are simply non-symbol visual displays, they may actually interfere with the operation of the logical processes inherent in language. Moreover, these are processes of a sort the child begins to acquire at quite an early age. What we must learn to do is to realize the immense power of verbal processes, and try always to develop these. Pictures as visual displays can, I think, help to this end: that is, in the teaching of words. It is probably only in special sorts of situations where the primary function of a picture is that of an iconic symbol, and validly to be regarded as a substitute for words.

Bruner (1963, 1964) interprets studies such as those we have considered, in terms of the difference between "appearance" and "reality." We all gain an acquaintance with the world through perception, but percpetion does not reveal enough (or it reveals too much, as see, 4.1.3) and what it reveals is often false. What is demanded is some means of operating upon perception (a) to correct it when false, and (b) to go beyond it so as to deal with the non-perceptible "entities" called concepts.

(a) The logical system inherent in language being far from perfect, is sometimes belittled by the symbolic logician who wishes to perfect this tool. There is no objection to this. But from the point of view of the present context, it is necessary to appreciate how truly amazing it is, and how important it is, that a child of only 5 or 6 years of age (quite without explicit awareness) has already begun to master the logic of his language. At this age he has mastered enough of this logical system to make it possible for him to "solve" a conservation problem *if denied access to the visual world*. A little later, around age 7, his linguistic rules are a little better established; he can then use these rules to reinterpret a visual impression on the spot (i.e., without hiding his head in a sack). Indeed, as an adult, he comes to believe that he *directly* sees the world the way he sees it, *because he believes that IS the way it is*. But such an adult has no awareness of what is involved, and as a responsible person interested in educating the young, this well-intentioned protagonist may believe that children see as he sees. He may be unaware, as Brown, Lewis and Harcleroad (1959) have commented, that verbalism has a twin devil, "pictorialism."

(b) The other thing that language does, is to make it possible to systematically falisfy sense impressions for a purpose; or to do without them altogether. Falsification and all this entails for science and the humanities has already been hinted at in our discussion of the design feature, prevarication. As for doing without sense impressions altogether, though, this of course cannot be. A senseless person would remain without sense: "vegetable" seems an intuitively suitable label for such a person. Helen Keller provides an intermediate example, she having lacked vision and audition, and so remaining not vegetable but "animal" until that point in time when she gained language and was humanized. But persons lacking only sight typically achieve language as rapidly as the sighted (Carroll, 1961) and function as creative members of a community.

I am underscoring the obvious at this point to say as strongly as I can, that students of pictures must not be the last to discover language; not, at least, if they genuinely have an interest in exploring the values of pictures. To this point, we now return.

Notes to Chapter Five

1. Hebb and Thompson (1954) have made the point convincingly: that the value for human psychology that is to be found in animal studies, lies at least as much in helping in the formulation of valid questions as in anything else. They illustrate this using the old nature-nurture controversy.

The "nature-nurture question" asked whether inherited factors or environment was most important in determining human intelligence. An implicit assumption in this question, as it was asked by early students of the problem, was that the age of the organism was immaterial. "Rat studies" showed that this was not so, that the relative importance of heredity and environment varied sharply with the age of the animal; and only then was this seen to be true of humans. Thus animal studies clarified thinking on a problem at the human level, even though these studies proved nothing about humans.

2. This illustration is technically faulty (as see the discussion of "pivotal words" in Brown and Bellugi, 1964). However, the illustration is adequate for its intended purpose.

3. Carroll (1961) states: "The utterances learned in the period 12 to 18 months are particularly likely to be learned as whole units even when from the adult point of view composed of several words, and their pronunciation is extremely imprecise." (p. 338)

Notes to Chapter Five (continued)

4. The literature on learning-set learning is extensive. In separate reviews of learning-set learning Harlow (1959) lists 71 references, and Miles (1964), 132 references. There is no attempt here to survey or even to sample this literature. Rather, I have depended primarily upon the Harlow and the Miles reviews.

5. Hebb (1949) makes a number of points that seem to support some such notion as is developed in the text. Hebb claims (a) that in the case of simple habits, lower species and the feeble-minded learn as fast as normal man; (b) that first learning is slower in the higher than in the lower species (though see below); and (c) that it is only when it comes to complex learning in mature animals that species differences become clear and orderly. It may possibly be the case that learning-set learning demonstrates species differences more clearly than have typical studies of animal learning, but only because learning-set learning is more complicated.

Harlow (1959) takes exception with Hebb's point in (b), above. Harlow questions this "because initial discrimination learning in the infant monkey is at least as rapid as initial discrimination learning in the infant rat . . ." (p. 508). The question that remains is whether or not "initial learning" (Hebb) is to be taken as the same as "initial discrimination learning" (Harlow).

Notes to Chapter Five (continued)

6. Miller, Galanter and Pribram (1960) have developed a similar notion. However, my own thinking developed independently of anything written by these students.

7. This has been asserted by Bruner (1964), whose thought on this matter has much influenced my own.

8. Strong support for this view is to be found in Chomsky (1962), Lashley (1961), and in Miller, Galanter, and Pribram (1960). This last represents, for Miller, a reversal of an earlier view (Miller, 1951).

9. Professor Moshe Anisfeld has taken exception with me on certain matters related to Figure 5.1 (personal conversation). He has suggested, first, that identity and equivalence categories can be differently regarded in terms of the distributions of their members: that the members of identity categories are temporally distributed; while the members of equivalence categories are this, and spatially distributed as well. This seems to me to be a quite useful idea.

Professor Anisfeld suggests, as well, that both identity and equivalence categories have perceptual and conceptual sub-types. I would agree with him that equivalence categories have perceptual, as well as conceptual sub-types, as my example in terms of the blue 1961 Ford convertible implies. I am not so certain, though, that identity categories are usefully to be thought of as having a

Notes to Chapter Five (continued)

conceptual sub-type. However, I do not regard our seeming disagreement as being in any way fundamental, as is implied by my use of a true perceptual/conceptual continuum in Figure 5.1.

10. One wonders how reliably and precisely the conditions justifying application of the term, physiognomic perception, could be set forth. Werner and Wapner (1952) describe a variant of motor theory called "sensory-tonic field theory," in terms of which physiognomic perception can be described more precisely. It refers to a perceptual situation in which the exteroception (say vision) is partly determined by a proprioceptor input (motor state) and an interoceptor input (affective state). Also, an exteroceptor can be predictably altered by input into a second exteroceptor, as the studies of a number of Russian psychologists show (London, 1954). For example, the visual percpetion of the vertical can be predictably displaced by an asymetrical sensory input (e.g., by asymetrical auditory stimulation, but also by electrical stimulation of the neck muscles on one side but not both.)

11. Only Skinner (1957) has given a theory of language learning in sufficient detail to be worthy of the name: and he is clearly wrong (as see Chomsky, 1959). While any theoretician can talk himself out of any hole, some of the efforts are quite pitiful. A psychologist or educator, as Carroll (1961) cautions, is especially likely to appear foolish in making pronouncements about language

Notes to Chapter Five (continued)

learning if he has not bothered first to learn what is the nature of language.

12. Carroll (1961, p. 337) has quite rightly pointed out that Irwin is in error in speaking of phonemes before the point in development where these sounds have semantic distinctiveness for the infant. However they are the sounds that, for the most part, will come to function as phonemes, and so Irwin's oversight would seem irrelevant to the argument in the text.

13. This case history is reviewed by Ursula Bellugi in the Harvard Educational Review, Volume 34, No. 2, Spring, 1964. Bellugi reports in this review that other evidence is presently emerging that supports Weir's findings.

14. Brown and Bellugi (1964) do not give an ending date for their study. Apparently it was continuing as of the time of their report, hence about two years in progress.

15. Brown and Bellugi (1964) use the term "functor" where, for consistency, I have continued to use "formator." "Formator" is not a precise term in this context. In particular, the class of words the child regularly omits when repeating a model sentence include formators as earlier defined in this monograph, but also such forms as inflections. Inflections are parts of words: for example, endings, as illustrated in the text, that change the signification of the root.

16. This reference to "prothesis" is made by Bruner (1964), who quotes Weston La Barre.

6.0 SPECIAL USES FOR PICTURES

> My Dear Colleague /Jacques Hadamard/:
>
> In the following, I am trying to answer in brief your questions as well as I am able. . . .
>
> (A) The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be 'voluntarily' reproduced and combined. . . .
>
> (B) The above mentioned elements are, in my case, of visual and some of muscular type. Conventional words or other signs have to be sought for laboriously only in a secondary stage, when the mentioned associative play is sufficiently established and can be reproduced at will. . . .
>
> (C) . . .the play with the mentioned elements is aimed to be analogous to certain logical connections one is searching for. . . .
>
> (D) In a stage when words intervene at all, they are, in my case, purely auditive, but they interfere only in a secondary stage as already mentioned. . . .
>
> With kind regards. . . .
>
> Albert Einstein[1]

Our concern in this chapter is with the sorts of circumstances that, it has been claimed, indicate the use of pictorial representation. We then consider some uses of pictures of a sort widely ignored to date, that relate to the "structure of knowledge" (as that phrase will be used later on). We conclude with a summary of some of what has been said in previous chapters. The intent in that concluding section is to summarize selectively, so as to point up the most pervasive difficulties encountered in studying pictorial communication, so as then to suggest general strategies for coping with these difficulties. Also, I try at that point (6.4.1.2.3.) to state more completely what I think is the main lesson to be learned from the Bruner experiments discussed in Chapter 5.0, just preceding.

6.1 The Utility of Pictures

A content analysis[2] of 63 statements claiming some special utility of pictures, yielded four broad categories, plus a "garbage can" category. The latter included 18 statements, or more than one-fourth of the total number. These statements were tautological, or true but entirely trivial, or uninterpretable, or false in that they depended upon an implicit invalid assumption. Of the four interpretable categories, one has already been considered. (This category contained statements which asserted that pictures may be especially useful when the credibility of the communicator is in doubt; as see 4.5.1.7.)

Another of the four interpretable categories is worthy of only brief mention. This category contained statements that asserted that pictures are especially useful when factors of time, space, or size preclude dealing directly with the phenomena of concern. And this, certainly, is often true. Through the powerful pictorial technique of animated motion pictures film, to take one example, one can overcome several sorts of barriers to understanding.

One can overcome not only historical time and space, but also contemporaneous problems in dealing with the too big, the too little, the too fast, the too slow, the too distant. In principle, though,. one can also do this verbally. One speaks or writes of the past and the future, the near and the far, the microscopic and the macroscopic. In short, these statements are uninformative relative to the merits of digital and iconic modes of representation. Any needed space or time or size compression or expansion is not, a priori and in general, better handled one way or another.

We consider the two remaining categories of statements about pictures in some detail. The first of these concerns the presumed dramatic impact of pictures. The second concerns the use of pictures as substitutes for language when, for whatever reason, language is "unavailable."

6.1.1 When Dramatic Impact is Desired. The emotive importance of iconic signs is widely recognized. It was no surprise, therefore, that a category of statements should emerge from our list of "pictorial strengths" that asserted as much. That iconic signs often have an interest value in their own right can be inferred from the definition of iconic sign as one that shares criterial attributes with its referent. If the referent has interest, it is plausible that a highly iconic representation of it will also have interest.

In the quantity of information they present, iconic signs are more analogous to sentences or paragraphs (even to more extended statements) than they are to words. The simplest picture contains at least one subject, for which several and often many attributes are predicated. Every "pictorial noun," inseparably and at once, is also a number of "pictorial adjectives."

Referentially though not emotively, this last mentioned characteristic is a shortcoming of pictures. This is to say that the requirements pictures must meet will sometimes vary in the extremes as between the typical instructional situation, and situations where the intent is to entertain or dramatize, or to gain attention or maintain it. In the first or instructional situation, the usual concern is with reference making, including making reference to equivalence categories. This circumstance typically calls for barren, schematized pictures. In the second sort of situation where the concern is to interest another or to motivate him, the realistic picture is ordinarily called for.

Because a realistic picture can present a large non-denumerable number of details, all at once, it thereby has the potential for conveying a very large variety of slightly varying nuances of feeling tone. This is not so readily accomplished with words. Poetry provides an exception for some people, though in poetry the use of words is to quite an extent a non-language or analogic use. As T. S. Eliot has insisted, good poetry must arouse vivid (presumably iconic) imagery.[4]

6.1.1.1 Dramatization to gain genuine acceptance. Drama is valuable in the classroom in its own right. For example it puts the student in "contact" with the great men in a field, as via the filmic medium, in a way not ordinarily possible by other means. A possibly more important use of the dramatic potential of this form of iconic representation, it seems to me, is to help gain the student's acceptance of what, otherwise, is often only "intellectualized." This use provides the student with whatever is necessary in order for him to gain understanding in an area where thorough understanding depends upon a genuine acceptance of an idea, but of an idea it is difficult for the student to accept either because of remoteness from his everyday experience, or because the idea is seen as detractive of his self image. Examples are easily found in areas such as clinical psychology, and the following material is drawn from that area.

One example comes from the realm of group therapy. The verbal description of the manner in which group therapy operates often strikes the uninitiated as ludicrous. This seems in part to be a result of how little the therapist does on a manifest level, relative to the dramatic changes that are presumably wrought in the personalities of the participants. Thus a major talent required of the therapist, it too often seems, is the ability at appropriate moments and in an appropriate tone of voice to say, "uh-huh."

"Unconscious motivation" is another such difficult-to-accept phenomenon; especially, it would seem, to the properly indoctrinated graduate student taught to revere (scientific) method more than ideas.

There are films that deal with these clinical topics; but in my own sharply limited experience, these films are not sufficiently persuasive for the student who is just beginning his clinical training. After some acquaintance with "psychodynamic theory," though, some students will begin to believe that they believe this "stuff." It will often be clear, nevertheless, that many of them have not really accepted these notions on the "gut level" (to use a crude but descriptively apt phrase). This is best seen when one observes what happens as the more advanced student views a good filmic portrayal of group therapy or a filmed demonstration of the operation of unconscious motives. It is not unusual at this later point in time to hear a student's expression of surprise at "finally understanding." Sometimes these expressions are best described as "confessions" (of the student, to himself): that, though he thought he previously understood and even accepted such and such idea, he in fact neither understood it fully nor accepted it without reservation.

This last was illustrated in a news story. An instructor at Duquesne University showed his class on counseling a print of the TV program "Eleventh Hour." The particular film he showed was an hour-length dramatization of the experiences of five strangers participating in group therapy. Following the film, the instructor had each student make an evaluation. All students were enthusiastic about the film, but the thing of most interest was the particular nature of the comments of some of these students.

Thus several of them commented along the following line: "I didn't quite understand what group therapy was until I had seen this picture. It helped me to see how a therapist can conduct a session without extensive questioning" (Indianapolis Star, December 22, 1963). Of course we must leave it open as to whether or not this that the student finally came to accept was "the truth."

6.1.2 When Language is Referentially Insufficient.

Verbal language may be insufficient in the emotive realm as just described, or in the referential realm, described next. The second of two earlier-mentioned categories deriving from the content analysis noted above, contained statements concerning such referential insufficiencies: for example, that learning may be facilitated through the use of pictorial symbols when speech is unavailable to the learner because the speaker and the learner do not share a common language in the relevant area of discourse (due to discrepancies in age, education, intelligence, and such); or because the members to the communicative act do not share a common language at all.

A sub-class of such cases are those related to retrogressive or diseased mental states. According to Ruesch and Kees (1956) digital processes are lost earlier than are analogic (iconic) processes in retrograde cases. Consequently, nonverbal communication may be relatively most effective in the earliest phase of therapy.

6.1.2.1 Language learning. Language learning is the grand example of which the above and other related cases, are instances. Pictures are thus useful (a) in teaching new concepts as in first language learning, and (b) in teaching new names for already established concepts as in second language learning. It is probably the case that realistic pictures are most generally called for in the case of first language learning, while schematized pictures are most generally required (because more efficient in being capable of more general reference) in second language learning. Excellent illustrations of this last use of pictures are found in the "Language Through Pictures" texts of Richards and others, already referred to. The utility of pictures in these two types of cases is widely appreciated. Unfortunately, the techniques of application are largely intuitive, as is so generally the case throughout the whole pictorial realm.

Quine (1960) speaks to the first point above (of first language learning), thus: "Each of us learns his language from other people, through the observable mouthing of words under conspicuously intersubjective circumstances. Linquistically, and hence conceptually, the things in sharpest focus are the things that are public enough to be talked of publicly, common and conspicuous enough to be talked of often, and near enough to sense to be quickly identified and learned by name; it is to these that words apply first and foremost" (p. 1, emphasis supplied).

The major role of pictures in language learning, is to thus increase the broadness of the range of "conspicuously intersubjective circumstances" within which tutor and learner interact, by making public through iconic representation, that which would otherwise be private; and by making this that is made public, also common, conspicuous, and near to sense.

6.2 Some Inadequacies of Language

The statements forming the largest category deriving from the above mentioned content analysis, all summarized the same main idea: that pictures are useful when language won't "work." But language might not "work" for two rather different reasons. There may be inadequacies in a language user, or in language, per se.

It was clear that the authors of these statements had in mind failures resulting from some inadequacy in the language user. The possibility of inadequacies in language, as such, was almost totally ignored as regards the category under discussion. Taking this as a clue, we shall therefore look for inadequacies in language of a sort independent of particular language users; that is, we shall look for inadequacies of a type that arise because a particular language has not encoded some facet of "the world" that is of interest to the communicator or interpreter.

6.2.1 When Language Has Not Encoded Some Aspect of "The World."

There is a frequent need to refer to simple, symmetrical, geometric forms; to circles, squares, rectangles, triangles, trapezoids, and such. And for the most part, reference to these common geometric shapes is efficiently handled verbally. But there are statistically rare states of affairs which, if encoded by language, would place a large burden on the language learner. Included most prominently are uncommon visual-spatial arrangements of the sort typically encoded by means of logical pictures (maps, diagrams, circuit schematics, etc.). Of course one may wish to refer to these latter visual arrangements occasionally, but language is relatively inadequate here, and in any case, all such visual arrangements are readily encoded iconically.

This type of case is summarized under Roman I in Table 6.1. Roman I includes another, similar situation; the sort wherein the single terms of a language vocabulary label rather broad equivalence categories, but without providing the modifiers for systematically narrowing these categories. Ordinarily, broad reference is all that is required in such cases as this, but there may be an occasional need to make narrow reference. Iconic representation is often useful in such instances. For example, it is interesting to contemplate that it would take more words than exist in the English language, simply to name the colors that can be distinquished by the average-sighted person. English has about five million words,[5] but man can discriminate about seven million different colors.[6] We ordinarily get along with a couple of dozen color names; but when fine distinctions must be made, it will usually be necessary for us to base these discriminations on matchings of actual color samples.

6.2.1.1 Codability. It will be helpful to concretize the Roman I case in other ways, in order better to introduce the concept of "codability." A person well acquainted with a city might not know the location of a small obscure store located therin; but since the questioner knows the city generally, an informant would have no need to draw a map in order to successfully direct his interrogator to the store. A direction such as "it's in the alley directly in back of Sears" might suffice. But in a case such as this, the interrogator and the informer share a considerable body

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WORDS MAY NOT SUFFICE FOR COMMUNICATION WHEN:

The individual user of the language lacks some language skill (e.g., 6.1). . . .

or when

Language has not encoded "the world" in the area of interest.

I.	II.
There may be statistically infrequent states of affairs which, if encoded by language, would put a big burden on the language user; and that are of a sort readily encoded by iconic symbols. These would include spatial relationships, and many types of identity categories. (Examples: logical pictures; the use of icons for dramatic purpose; the identification of individuals.)	Some things aren't coded because they have not been of concern to the speakers of the language in the past. (Examples: Worf, Hadamard; psychotherapy.)

Table 6.1 -- A scheme suggesting the nature of some situations wherein words are inadequate for communication.

of knowledge, accumulated over a period of months or years, all of which is relevant to a single city. But no matter how extensive one's knowledge about this or that city, and whatever one's past verbal habits might be, maps are more efficient message forms than verbal-only instructions when the city encountered is a stange one. The point, of course, is that the patterns of pathways through most cities are non-recurring. Of course, if most cities were laid out in the regular, co-ordinate manner of Salt Lake City, for example, things would be quite different with respect to the present point.

Consider, finally, this possibility: that in proper context at a highway crossroads, verbal and iconic highway road markers will be equally adequate for directing the driving behavior of a literate English-speaking adult. But if such a driver were suddenly set down on the highways of Tokyo, he would be safer if all highway signs were iconic than if they were printed in Japanese. After a while, though, such a driver would begin to acquire a few Japanese words to insure his safety and enhance his pleasure; and the longer his sojourn and the greater his astuteness, the more rapidly would the difference in efficiency of signification between iconic and digital signs diminish.

What it is important to note here, I think, is that there is nothing in the Roman I case that gets at the problem of intrinsic differences between iconic and digital signs. Rather, the Roman I case suggests that the degree of precision and ease with which one can verbally refer to some aspect of one's phenomenal world depends (a) upon the importance of various matters to the language family of which one is a member, and (b) the ease with which these matters can be alternatively encoded by visual-iconic means.

We will refer to the ease and accuracy with which something can be encoded, as its "codability." Or as Brown & Lenneberg (1961) define it, codability refers to the "differential availability of reference categories" (p. 485). But whereas codability has generally been used to refer to the ease and accuracy with which something can be verbally encoded, this term will be used here to refer to "iconic codability" as well. Thus one would presume on purely logical grounds, that pictures would be most useful for encoding statistically rare recurrences that are of moderate importance, and that readily lend themselves to visual-iconic representation. This, of course, describes the type of case referred to in Roman I.

6.2.2 The Technology of Language and the Psychology of Invention. The Roman II case (Table 6.1) brings us to a quite different matter: viz. the situation wherein the concept of our concern (a) may not have been invented by the society at large or (b) if it has been invented, this is not known by the particular individual of concern who (lacking a tutor, the necessary books, or whatever) must get the idea on his own if he is to get it at all. In the process of invention the value of intuition and of iconic imagery (or of physical model building or other uses of of iconic representation) may be very great even though the concept, once invented and attained by a speech community, will be most economically dealt with by means of its verbal name. Perforce, the line followed in the present section is quite speculative.

Let us tentatively accept two old ideas in the role of working assumption: (a) that relative to thought of the pedestrian sort adequate to the solution of well-worn, traditional types of problems, creative thought is relatively independent of verbal processes and relatively more dependent upon visual-iconic and kinetic-iconic processes; and (b) that creative thought is more a matter of question formulation than of problem solution.

6.2.2.1 That language is a technology. The plausibility of the assumption that creative thought is, in significant measure, nonverbal, is enhanced by an understanding of the "technological" character of language. Consider that an automobile, a system of mathematics, a wheel barrow, a computer, and a language, all have a number of things in common with technology. All are instruments or techniques that serve human purposes of whatever laudable or insane sort. All were created by earlier generations, and were modified and modified again; and each has been handed more or less intact to succeeding generations. In no case mentioned is there a requirement that the user of the mechanism have any understanding of its fundamentals. One need not experience Archimedes' creative insight that illuminated the principle of the lever in order to make use of a wheel barrow, nor understand the structure of geometry to put the Pythagorean theorem to work, nor understand any sort of mathematics in order to employ todays complicated calculators. Of course one may need to know a few mathematical mechanics in order efficiently to use a computer, just as one must develop certain perceptual-motor skills in order efficiently to use a wheelbarrow or to perform a routinized brain operation. The differences in the complexity of the particular skills that are required are as widely variant as the chosen examples suggest, but all these skills are or can be employed in an essentially mechanistic manner.

Similarly with language: a child, a primitive, a literate adult and a scholarly linguist all use "language technology" with great facility to solve a broad range of immensely practical problems; and they do this even though their knowledge of their language and especially of its grammar, is very much incomplete. It is incomplete for the linguist, quite slight for the average literate adult, and nil for the young child and the primitive.

Language is most obviously a technology in those situations where it most obviously functions (very nearly) automatically. In the execution of simple habits like counting, for example, one can "turn on" one's jaw very much like one would turn on a calculator. Once one's jaw muscles (or some covert correlate of jaw-muscle action) is set loose, it is quite possible to stay aloof of the need to think, and one thereby avoids any danger of strain to one's brain. Counting is a very important technology, for if the number of objects (such as chairs in a room) is something like seven or more, one cannot directly perceive that number (Miller, 1956), and no other device is so readily available for this purpose as is the "counting technology" of language.

The counting technology of the modern computer seems even more amazing. For example, a digital calculator christened The Logic Theorist by Newell, Shaw and Simon (1962), was programmed by those authors in such a way that it succeeded in solving problems originally solved by Whitehead and Russell in their Principia Mathematica (1925-1927). A question that therefore arises is this: is The Logic Theorist creative?

There can be no doubt but that Whitehead and Russell were creative in their own effort, for their work is "the foundation of modern renaissance in logic. . ." (Whittaker, 1955, p. 5). It would seem that creativity could therefore be defined at least in the present case, as whatever "X-quality" it was that was necessary in order for Whitehead and Russell to make their prodigious contribution to knowledge. But if we make this assumption, we seem thereby to accept that the machine, The Logic Theorist, was also creative; for this electronic-mechanical device accomplished the same solutions as Whitehead and Russell, and in certain instances it did this more elegantly than did Whitehead and Russell (Newell, Shaw and Simon, 1962).

One important difference, though, as the programmers of The Logic Theorist note, was that this calculator was supplied with the problems it solved whereas Whitehead and Russell had to discover their own problems. If one would hold to the notion that Whitehead and Russell were more creative than The Logic Theorist, one is lead to consider the possibility that it is in the formulation of a good question that creativity must lie. Thus the solution of a difficult problem may not be a solution of *that* problem, but primarily the formulation of a new problem and, only secondarily, the *formulation* of a new problem and, only secondarily, the *solution* of the new problem. Perhaps it is true that once a question is well formulated, its solution can be mechanised.

6.2.2.2 When language misleads. The range of application of the most highly developed technological devices is sometimes extremely narrow. Thus the covered wagon of pioneer days could negotiate todays highways, and also the nearly nonexistant wilderness paths of the Old West, while todays modern motor car is less adequate even than a water buffalo for negotiating swamps.

Similarly with language. The power and efficiency of language for purposes for which it is suited can hardly be exaggerated. At the end of the last chapter, for example, we considered the importance of language in helping the child *transform* the perceptual world in those cases wherein appearances and reality failed to correlate. But as implied by Einstein's letter to Hadamard (quoted as preface to the present chapter), language may be of little use in first coping with fundamentally and distinctively new problems.

The point here is that the "logic of language" is not unimpeachable. Old serviceable conceptions sometimes lose their applicability in the changed contexts that characterize the frontiers of knowledge. In such cases, conception may not only fail to correct perception, but may mislead perception, hence mislead further conception. The well-worn example of Einstein's difficulty in first seeing the totally intimate relationship between "space" and "time," illustrates the point very well. It has been suggested that a Hopi Indian would not experience this particular difficulty, because his language does not mislead in this respect as do Indo-European languages (in the sense that the latter force a separation of the inseparable: in the present instance, of the unitary notion, space-time).

Other anecdotal examples are reported by Hadamard (1945), who is explicit in urging the view that creative thought is highly dependent upon the use of visual-iconic imagery. Hadamard questioned quite a number of extraordinarily outstanding mathematicians and scientists concerning the kind of imagery they used in solving new and difficult problems. Most of them agreed that words, numbers, and other digital symbols had to be supplanted or supplemented when first dealing with unusually intractable problems; but some of Hadamard's scientist-respondents explicitly denied that this described their own case.

6.2.2.3 External and internal "pictures." The foregoing is not directly related to the use of the iconic sign vehicle, as this notion ("sign *vehicle*") was earlier distinguished from "sign" (3.4.4). The reader will recall that the "vehicle" was identified as the external stimulus object (the word or picture), whereas "sign," per se, was icentified as the dispostion to respond that was elicited by the vehicle.

The kind of iconic representation referred to in the preceding section is the *internal* iconic image or "mental picture." Such "internal processes" can also be digital in character, and there can be no doubt but that this is commonly, perhaps prominently, the case. The relationship between internal and external representation, and between iconic and digital representation, is a matter of immense importance. But this is something we know almost nothing about. It seems clear, though, that the former distinction is intimately related too--indeed, is largely coterminous with--the distinction between social and nonsocial communication. The linguist Roman Jakobson has commented most suggestively on this matter, as follows.

> "Signs are a necessary *support* of thought. For socialised thought (stage of communication) and for the thought which is being socialised (stage of formulation), the most usual system of signs is language properly called; but internal thought, especially when creative, willingly uses other systems of signs which are more flexible, less standardised than language and leave more liberty, more dynamism to creative thought" (Jakobson in Hadamard, 1945, pp. 96-97, emphasis supplied).

One is once more reminded of Einstein's letter to Hadamard, wherein the great physicist explains that in dealing with the difficult problems on the frontiers of knowledge, he often had to abandon the use of words or numbers and employ visual and kinesthetic images. The use of visual-iconic imagery is nonsocial, but it would seem doubtful that even if this imagery could be externalized, so as to be observable by another physicist, that the latter could then evolve Einstein's new conception only with this aid. But if clear renderings of Einstein's internal iconic imagery could be magically externalized and supplied as an accompaniment of the secondarily developed discursive exposition that Einstein was later able to develop, then such iconic renderings might have high facilitative value for the second physicist as he struggled to gain Einstein's new conception.

Of course nature is too subtle to yield to armchair speculation of this sort. Even if every idea put forth here was known to be factual, one would still have to ask concerning putting such ideas to work in deriving researchable questions in order to extend this understanding. But deriving researchable questions from what has so far been said would seem to require that one deal with the concept "mental image," hence find some way to operationalize that concept; and the liklihood of succeeding in this at this time seems remote. However, the foregoing suggests a class of research questions that do not have to be formulated in terms of the concept, mental image, once these ideas are interpreted within the frame of reference suggested by a second concept, the "structure of a subject."

6.3 The Structure of a Subject

The creative scientists studied by Hadamard (1945), and just reported upon, were especially likely to employ iconic mental imagery when grappling with the most difficult problems in their field. And, apparently, the important thing about the "mental content" involved was that often, this did not consist of images of the real or phenomenal world. That is, these were not necessarily images of visible or potentially visible, bounded elements or objects, but of the structure of elements or objects. Hadamard did not use the term "structure" (at least not technically or systematically), but it seems clear from his description that he himself employed what we would call "logical mental images" (after the idea of "logical picture").

Apparently, Einstein also used logical mental images, but more certainly, he used a kind of iconic mental image that we shall refer to later in this section as a "pictorial analogy." The elements of those of Einstein's structures that I here call "pictorial analogy" are visible (e.g., as describes Einstein's report of imaging kinesthetic sensations produced by accelerating elevators), but the particular character of the elements imaged was not the crucial thing in problem solution.

These kinds of observations become suggestive when cast in operational terms. The development that follows shows a way to begin along the suggested line. To anticipate the position developed: the great utility of iconic representation in mathematics and in the more basic physical sciences, does not lie primarily in the fact that iconic symbols can realistically portray the real or phenomenal world; rather, that such symbols have a potential for showing the structure of a science; and this includes portraying "non-reality."

6.3.1 What is Structure? The concept of "structure" in the phrase "structure of knowledge," is not different in any essential from what one thinks of in reference to the various physical structures formabl from, say, a pile of bricks and some mortar. Thus one can build quite different-looking houses with the same materials. Similarly, a knot (e.g., a square knot) remains the same knot (i.e., maintains a constant structure) through changes of material (e.g., from rope to wire to string), as well as through changes in the shape of the curve of the rope (or wire, etc). One can even translate behavior, in general, into the terms of topological geometry (as Kurt Lewin has successfully shown), maintaining certain structural equivalences. One can then manipulate this structure (or "model" or "theory") and thereby derive testable predictions about behavior.

The structure of thought in some area might refer to the hierarchical arrangements of the concepts relevant to that area. On the simplest level, one may hold regard for a concept such as "number" and consider various types of numbers. The mathematician understands that the several types of numbers can be arranged into several different logical structures. The various types of numbers could be learned as a list, of course, by memorizing a list of definitions, but this approach is grossly inefficient; and the mathematician recognizes that someone who could parrot such definitions and yet was unable to organize the concepts defined, into various logical structures such as follows, had surely failed fully to grasp the concept of number.

- Complex numbers
  - Real
    - Rational
      - Integers
        - Positive
        - Negative
        - Zero
      - Fractions
        - Positive
        - Negative
    - Irrational
      - Algebraic
      - Transcendental
  - Imaginary

We can say the same sorts of things about arrangements of numerals. Of the following two arrangements of ten numbers, for example, the first is more easily remembered than the second: 1, 2, 3, . . . 8, 9, 10, vs. 8, 3, 7, 1, 2, 10, 4, 6, 5, 0. Indeed, it is unnecessary in the case of the first set of numerals, even to indicate all the members, and not all were indicated here. It is only necessary to indicate the structure, for when one grasps the structure, one is able to fill in what was left out.

While all readers will grasp the ordinal aspect of the structure of the set of real positive integers, there are other aspedts of this structure which might not be immediately evident. Consider, for example, the problem of finding the sum of the positive integers from 1 to 10. This is accomplished fairly readily by rote technical/mechanical means, but if one understands more than the ordinal aspect of the sequential structure represented in the accompanying illustration, one may solve this "addition problem" very quickly indeed. The mathematician Gauss did so, and at the ripe age of six years (Henle, 1962).

$$1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 = ?$$

$$\begin{aligned} 1 + 10 &= 11 \\ 2 + 9 &= 11 \\ 3 + 8 &= 11 \\ 4 + 7 &= 11 \\ 5 + 6 &= \underline{11} \\ &\ 55 \end{aligned}$$

That which Gauss might have done, was to directly "examine" a visual-iconic image that may have looked like the accompanying illustration. But whether or not he did this, and whether or not he used any kind of iconic imagery, there can be no doubt that Gauss understood the particular aspect of structure that was made obvious in the above logical picture. That is to say, it would have been necessary for Gauss to have seen that the two terminal numbers, the two next-to-terminal numbers, etc. all had the same sum, 11. If he had failed to grasp this facet of structure, he would not have gained an instant solution to this problem. But in having seen the structure of this particular string of integers, it is quite certain that Gauss could then have arrived quite quickly at the solution when the string was extended from 1 to 100, or to 900, or whatever.

Structure exists at different levels. If one is a carpenter building a house, the parts are boards, nails, etc., and the structure is the arrangement of these parts to form a particular house. But each part also has a structure. For a carpenter a board is a part, but for a person interested in plant life, the board may be a structure whose parts are cells. For the cytologist, the cell might be the structure whose parts are the bio-chemist's structures, etc.

6.3.1 Types of Signs and the Structure of Knowledge. It is obvious enough that the structure of a subject is different in different subject-matter areas, even though there are commonalities across all the area of knowledge. But do pictures and other visual-iconic symbols have a unique place in teaching structure? To answer this question requires analysis (a) of iconic symbols, and (b) of the structures of the various realms of knowledge, so that the two things can be compared.

We can begin this two-fold task by drawing upon the analysis of visual-iconic symbols given in foregoing chapters. We can bring this understanding to bear in examining what seem to be the more effective uses that have been made of iconic representation in such contrasting realms of knowledge as the formal vs. the natural sciences, the physical vs. the social sciences, etc. Of course we are going to have to depend upon the scholars in the various disciplines in solving the second part of this problem: that of understanding structure in the various realms of knowledge. But even here we can make a beginning as Phenix (1964) has recently done in undertaking to characterize the various "realms of meaning" (as he has entitled his book). The educated layman, thus armed, can point out the more obvious differences in the structure of knowledge between such markedly different subject-matter areas as, again, are most visible in comparisons between formal and natural science, particle physics and sociology, etc. In the two following sub-sections, I undertake to suggest how these two interrelated activities might proceed.

6.3.1.1 Types of visual-iconic signs. We have spoken of the realistic vs. the barren or schematized picture, and of the logical picture. We have said that the realistic picture is generally most useful for emotive, interest-gaining purposes, for signifying identity categories, and in providing representations of exemplars of referent categories in first-language learning. The schematized picture is generally most useful in the referential (as contrasted with the emotive) realm, in making reference to equivalence categories, and in facilitating second-language learning.

The concept of "logical picture" (4.4.4) has special interest in the present context. A logical picture is a representation of a state of affairs of a sort wherein the elements (objects, bounded entities) are aribtrarily portrayed, while the spatial relationships between these elements, or their order of connection, or both, are isomorphic as between the "picture" and the state of affairs depicted. Thus the foregoing arrangement of numbers is a logical picture. The value of the logical picture lies in this: that by giving only arbitrary representation to the elements, one is thereby free to signify relationships, iconically. It seems thus possible to show "structure," iconically. It is not possible, iconically, to unambiguously signify relationships, hence structure, if the elements related are themselves iconically portrayed.

An examination of picture-rich sources such as *World Book Encyclopedia* or the publications of the Time/Life Corporation (especially the books comprising the Life Science Library) reveal other types of visual-iconic symbol. An informal content analysis of one of the books in this series (*The Cell*, Pfeiffer, 1964), shows the very important uses of pictorial analogies of several varieties. For example, an intuitive appreciation of the smallness of certain units in biology is given by means of extrapolation through pictorial analogy. Thus the verbal analogy

$$\frac{\text{Height of Empire State Building}}{\text{Length of a firefly}} = \frac{\text{One inch}}{\text{One micron}}$$

is rendered pictorially. In another case, a golf ball is likened to an electron, and the golf club to a photon, so that a golfer hitting a golf ball and careening it off of a series of trees lining down a fairway, provides an everyday circumstance that can then be likened to what happens when a photon hits a chlorophyll molecule. Or again, in illustrating mitosis, cells are likened to people and chromosomes to toy balloons, so that a certain familiar people/balloons relationship can aid the learner in grasping the nature of an unfamiliar process involving chromosomes. And the explication of how the peculiar structure of the DNA molecule carries all the instructions needed to determine every genetic trait is in part explained by likening the duplicative function of a DNA molecule to the use of a template in a clothing factory to cut hundreds of identically shaped pieces of cloth in one operation. Indeed, if one removes from consideration those pictures whose only or primary function is historical, aesthetic, attention-getting, etc., the use of pictorial analogy (or metaphor) is a use as frequent as any other.

One also finds many logical pictures in The Cell. The picture of the DNA molecule is a most prominent example. The authors of The Cell note that the DNA molecule is composed of most ordinary chemicals--phosphates, sugars, and nitrogen-containing bases. They stress that it is not the nature of these component materials that is unusual, but the "ingenious structure" in which they are arranged. And the pictures of this molecule that are presented are not intended to be pictures of chemicals, nor magnifications of the molecule. Indeed, the "parts" are regularized geometric forms quite unlike anything typical in nature. It is the organization of these parts that is all important, and this is the point of the present section: that it is necessary to understand how the structure of knowledge varies from subject area to subject area, before it is possible to say very much about the uses of such types of visual-iconic representation as the logical picture, the pictorial analogy, the schematized picture, the regularized "realistic" picture, the realistic picture, and others.

6.3.1.2 The structure of knowledge. In a discussion of the microscope, the authors of *The Cell* present a realistic picture of a microscope of historic interest (one like that used by Robert Hooke in the 1600's). They also present a realistic picture of a modern microscope, and a schematic representation of a microscope of a sort designed to show the arrangement of lenses and how the mirror and the various lenses direct and modify the passage of light. While all this is presented in reference to a single topic in a single book concerned with a single narrow discipline, only the schematized representation is directly relevant to an understanding of the use of the microscope or the manner of its functioning; hence only this latter is of direct relevance to cytology. Of course the other illustrations serve important goals: they arouse interest, give a historical orientation and a partial basis for appreciating the difficulties and successes of the pioneers of the science. But as regards the present discussion of structure, it would be most useful to differently classify these different uses of pictures of microscopes. Thus while all scientists would have an important stake in teaching the history of their science, much that would be done by way of accomplishing this would, for present purposes, be better categorized under "history," than under the particular science of primary interest. Moreover, the instruments of all science might best be separately treated, when one's concern is the structure of knowledge. And so microscopes, intelligence tests, litmus paper, clocks, etc. might be most effectively dealt with together for what, in essence, they are: viz., extensions of man's senses.

Phenix (1964) takes these sorts of things into account. He approaches problems of the curriculum in a way intended to relate to the structure of knowledge in the various "realms of meaning." This is suggestive of differential uses of the several types of iconic representation in these several realms, and in a way that can be tested through quantitative analysis of instructional materials such as are represented by The Cell.

Phenix discriminates six "fundamental patterns of meaning," as follows: "symbolics," "empirics," "esthetics," "synnoetics" (or the existential aspects of literature, religion, psychology and philosophy), "ethics," and "synoptics" (history, religion, philosophy). He is concerned with the logical structures common to the disciplines subsumed under these labels, and with the methods of investigation and of validation that characterize the work of scholars in these several realms. But because our immediate problem is different, a different breakdown of the "realms of meaning" than given by Phenix seems called for.

Under "symbolics," for example, Phenix groups ordinary language, mathematics, and other discursive forms, together with nondiscursive (iconic) forms. Thus their is a fundamental distinction within this most fundamental of six "realms of meaning" that we must pay a great deal of attention to. Since the symbolic area is fundamental to all the other areas, and since it includes both discursive and nondiscursive forms, I would reorganize the realms of meaning given by Phenix in a way to show this. In the first place, the symbolic realm, per se, should not be regarded as a member of the category-set "realms of meaning"—not, at least, for the purpose of the present discussion. What it would be helpful to do, though, is to think of the possible uses of iconic representation for the task of teaching in some particular symbolic realm such as, for example, that of mathematics: even some particular area in mathematics. (The uses of iconic representation are likely to be quite different in, say, topology or in set theory, than in algebra or calculus.) The remaining realms can usefully be examined to determine the types of iconic and digital representation called for.

The realm of empirics would seem to require considerable fractionating, for it is not at all homogeneous as regards the types of iconic representation called for. Thus it seems obvious not only that the physical/biological sciences differ markedly from the social sciences, but that, for example, atomic and sub-atomic physics differ markedly from other more molar aspects of physics; and that cytology and bio-chemistry differ markedly from other more molar aspects of biology. These differences seem too great to permit dealing similarly with these different subject-matter areas as regards uses of iconic representation. The more basic sciences differ from the less basic sciences also in a way of considerable relevance to the student of pictures, in that the former, in being more abstract and general, have relatively more need for the logical picture than do the latter.

Consider only the most obvious differences in the fundamental units of analysis in the several basic areas of science: "atom," "elements," "cell," "habit," "interpersonal behavior event," "role," for example, are terms that name basic concepts that cover the range from physics to sociology. These include not only the visible and the invisible, but also the potentially phenomenal and the essentially non-phenomenal. Neither the structure of the atom nor of the cell are ordinarily visible, but that which is involved in making these two sorts of things "visible" is logically quite different in the two cases. The cell simply requires magnification of what is actually there, while the atom requires "invention" (as explained below). And when one compares natural and formal science, things are quite different in yet other ways.

To illustrate some of these points, let us compare algebra and biology. Algebra (or any logical system) is what is described as a formal science, for only the form or structure of "things," not "things" themselves, are of interest. Formal science is therefore independent of the need for semantical statement. In algebra one can use markers like "x" and "y" without defining these in any way; and even though it is didactically sound to give meaning to the empty markers in formal systems by arbitrarily linking them with features of the phenomenal world, still, a teacher has considerable freedom in deciding how best to do this. This is so because the particular way a teacher chooses to define his x's and y's is logically immaterial and (within wide ranges) neither is it crucial psychologically. For example, the "x" and the "y" in the formula $x^2 + y^2 = z^2$ may be defined as the legs of a right-angle triangle whose hypotenuse is "z; even when the subject area is algebra, not plane geometry. A teacher is likely to choose an illustration such as this, for no better reason than that a triangle is easy to draw. And in teaching a formal science, this would ordinarily be sufficient justification for such a decision.

In human anatomy, by contrast, one is "stuck" with the real world; one's concern is with real, and picturable, things; but with things not readily drawn on a blackboard nor generally available to direct perception. In this area, as in biology in general, realistic iconic symbols have immense importance.

Another dimension of variation is made visible by contrasting the subject areas of particle physics and geology. In the former area, schematized and idealized iconic symbols would be more generally useful than typically would be the case in geology, because of the highly general and abstract character of modern physics. The "material" investigated in sub-atomic physics is not directly visible, and the pictures physicists draw to display the structure of the atom are never to be taken literally. It was said above that the problem of picturing the cell involves magnification while the process of picturing the atom requires invention. This is to say that pictures of atoms are pictures of theories, not pictures of "the world." There is no reason to believe that an atom, enlarged sufficiently for viewing, would look at all like the pictures of it that are drawn. As Humphreys-Owen (1961) has claimed:

> The usual description of an atom as a collection of electrical entities (electrons) associated with a complex system (the nucleus) contains the inference that the electrons are "outside" the nucleus. Most would agree that this spatial statement is just permissable, but that any attempt to ascribe shape to the orbits of the electrons must fail. As for the nucleus itself, it is possibly illegitimate to give it any space-occupying property at all, other than in the experimental sense of "cross-section." In the deepest levels of the analysis form is the first to vanish, and later even the occupation of space loses meaning. p. 22.

It may be the case in the realms of synnoetics, esthetics and synoptics, that the most important types of iconic representation is the realistic picture (statue, or whatever); and that the traditional argument for the merit of pictorial representation -- in terms of the need for realistic representation--is generally valid in those realms. But iconic representation in the basic sciences would seem more valuable in regularizing the irregular phenomenal world (as in portraying a standardized cell that looks more like cells, in general, than like any particular cell); and most especially, in showing spatial and non-spatial structure through visual-spatial analogy as in picturing the atom, or in picturing the structure of a particular number system as was done earlier by way of illustrating how Gauss might have solved the addition problem posed by his teacher. Iconic representation would seem to have a widely ignored potential for "portraying" non-phenomenal matters, especially theories; or, more generally, for making the unfamiliar familiar through pictorial analogy or through pictorial analogy by extrapolation (as in the illustration in *The Cell*, earlier alluded to, that "showed" the size of a micron).

6.4 Summary: Measuring Pictorial Meaning

6.4.1 Pervasive Difficulties in Studying Pictorial Communication. The student of communication who has an interest in pictures is curious concerning the contributions of pictures and words in teaching some concept, in changing an attitude or inducing some action. But certain mis-understandings have hampered the pursuit of this goal. First, a very general type of difficulty has arisen because a pair of variables have typically been confounded with the "independent" variable in picture/word studies. These are (a) the variable of "codability"; and (b) differences that result because the effectiveness of a particular message is always partly determined by a communicator's idiosyncratic selection and arrangement of symbols (from the many possible alternative selections and arrangements available for choice). Second, it has not always been recognised that one cannot study the communicative efficiency of pictures relative to words, *in general*.

6.4.1.1 Codability, the grand confounder. The concept of "codability"—defined by Brown and Lenneberg as the "differential availability of reference categories" (1961, p. 485)—was discussed earlier (6.2.1.1). But the research problems in measuring or otherwise controlling codability are serious enough to warrant separate comment.

First, to illustrate the notion in additional ways, consider the German word *Weltanschauung*. This word names a concept whose description takes twenty-eight words in the dictionary authored by English and English (1958). Thus, although this concept is "available" to an English speaker, it is not so readily available as it is to most speaker of German.

A few years ago, cytologists could not easily make reference to the DNA molecule with anything less elaborate than complex physical models; and physical models will continue to be useful in teaching about this molecule. But today such elaborate means of making reference to DNA may be unnecessary for cytologists when talking among themselves. It may be necessary for them only to say, "DNA."

Codability, or the ease with which a communicator can cause an interpreter to make reference to some concept, is thus a continually changing thing. If, for instance, it should frequently become important for an English-speaking community to make reference to the concept named Weltanschauung, the community members would find an easier way to call this concept to mind than by employing twenty-eight or so words of description. They likely would borrow the German name. Indeed, as is suggested below, degree of codability can change significantly in the course of a single experimental session.

Codability is a concept of relevance for the pictorial communicator, because the utility of iconic representation is dependent upon the verbal codability of a referent. If verbal codability is high, the need for pictures is thereby less insistent. Still, this truism seems to have been widely ignored in certain contexts, and this is our present concern.

Let us first take the problem, not of comparing pictures and words, but of comparing two natural languages; for example, Hope and English. One might prepare a lesson in each of these two language, and compare learning outcomes. But a significant difference in outcome would not provide a basis for generalizing about differences in the communicative efficiency of Hopi, relative to English, even though such differences may exist (as, e.g., has been suggested by Whorf, 1956). One could not presume to interpret any such difference unless one had convincing proof that (a) the subjects used in the experiment were equally versatile in English and Hopi, and (b) that the compared Hopi and English messages were both encoded as adequately as the respective languages allowed. Proof of this sort is not likely to be attainable; but only if it were would one feel safe in drawing any inferences about the relative efficiency of Hopi and English for communicating in the subject-matter area examined.

Let us now consider how one might test an analogous hypothesis in the picture/word realm. One such hypothesis, and an often claimed and intuitively plausible one, is that iconic representation is superior to digital representation for communicating about the spatial arrangements of elements; as, for example, is done in road maps by way of showing the locations of towns and the manner of their connection by highways. One might wish to test such a hypothesis, however "obvious," because intuition has been known to fail.

Let us therefore imagine a study in which the subjects are native speakers of English with comparable native abilities and educational backgrounds. Let all subjects serve in counter-balanced order in both a "verbal" and a "pictorial" condition; and let the task require one subject to act half of the time as "communicator," in order to communicate the nature of an accidentally-determined visual pattern to a second subject, the "interpreter," who is to externalize his understanding of this pattern by reproducing it. Let the nature of the spatial arrangement be determined by having the communicator shake, then roll a set of small poker chips from a dice cup--in the manner of dice rolling in a craps game--so that the chips fall randomly on a small walled-off square of felt placed on a table. The communicator is to do this out of the sight of the interpreter, though not out of speaking range. The interpreter is to have a square of felt similar to that used by the communicator, and the same number of poker chips with which to reproduce the pattern the communicator describes to him.

In the verbal condition, the communicator shall verbally describe the nature of the accidental visual pattern he has formed, and the interpreter shall be told to quickly arrange his own poker chips according to this description. The communicator is to help the interpreter in this task in any verbal-only way he can think of.

In the pictorial condition, a poloroid picture is to be taken of the accidentally-determined visual pattern, and this pictorial instruction shown to the interpreter who is to arrange his poker chips to match the photograph as quickly as he can.

The contaminating effects of codability might seem to be controlled in this situation, since the visual patterns are accidentally determined, and are different for each trial. Thus the degree of their verbal codability would tend to be low and to remain low. At the least, the subjects could not gain by inventing names for these patterns, for they are non-recurring.

It might seem that in this circumstance the superiority of pictorial instruction would be indefinitely maintained; and, therefore, that the conclusion could be validly inferred that pictures are superior to words in communicating about unnamed visual patterns. But this conclusion depends upon the validity of the expectation that the verbal codability of the visual stimulus patterns would be low and remain essentially unchanged throughout the experiment.

The procedure just described was employed by Essig (1964) as a part of a larger study. Essig's most obvious finding was that there is a very large and highly significant difference in favor of pictorial instruction in this sort of experimental situation. He found, in other words, just what "common sense" would lead one to expect: that given an unfamiliar visual display, a subject cannot communicate its description with words as well as with pictures. But what about the expectation that verbal codability would be low and remain essentially unchanged throughout the course of the experiment?

Essig varied the number of poker chips used in forming the accidental visual arrangements he used as stimuli. He believed that as the number of chips was increased, the complexity of the visual form would tend to increase; and that the superiority of pictorial, relative to verbal instruction would increase with increasing stimulus complexity.

Essig's procedure was to use first one, then three, then six chips. He found that pictorial instruction was superior to verbal instruction in the one-chip condition, and that the magnitude of this difference increased significantly in going from the one- to the three-chip condition. But there was no further increase in the magnitude of this difference in going from the three-to the six-chip condition.

There is at least one plausible explanation for this last finding. In the verbal condition Essig observed much trial and error on the part of the communicator in trying various strategies for communicating quickly and accurately. Essig's study was not designed to give answers along this particular line, though, and so this was only his impressionistic observation. But if the same communicator and interpreter were to work together over an extended period of time in solving the problem of verbally describing non-recurring visual patterns, it would be a surprise if they failed to improve in this. For though communicator and interpreter could not resort to "naming," they could develop some system or other; for example, they might adopt the Cartesian coordinate system or some modification of it.

The point here is not that the hypothesis we have been discussing is false. Indeed, it is doubtless valid. Rather, the point is that the experimental procedures cannot be said to have prevented a change in codability, over trials, even with the noted precautions. (It should be pointed out that Essig was aware of this difficulty, and he was trying to better understand it. It is also worthy of note, that depending upon the hypothesis under test, the error described might sometimes be in the conservative direction so that a significant difference would be interpretable. Indeed, this seems to describe the present case.)

To summarize: an investigator who compares pictures and words in such manner that the picture/word difference is presumed to be the independent variable while measures of learning are the dependent variables, is in at least as difficult a situation as is one who would compare the relative communicative efficiency of Hopi and English. Such studies are highly likely to be confounded by an uncontrolled codability variable.

6.4.1.1.1 Message Multiplexity. Another facet of this same problem relates to the multiplexity of all messages. In the just preceding paragraph, for example, the following phrase was used: "the picture/word difference. . ." But one never has just one dimension varying in such cases. One always has several dimensions, varying at the same time.

As Miller, Galanter and Pribram (1960) have said in reference to the machine translation of natural languages, there is no determinable "best way" to translate a given message. Because messages are multi-dimensional, any improvement in a translation with respect to dimension W cannot be made without the very real possibility of an offsetting loss with respect to dimension X, Y, etc. And if this is so as regards the problem of translating from one discrete, arbitrary, discursive encoding system to another such system (as from one natural language to another natural language), one can well appreciate that the problem is multiplied when it comes to comparing one such system with a totally different type of system. For example, in comparing such a system with a continuous, non-arbitrary, non-discursive "system" such as the iconic.

In fine, one cannot test differences between iconic and digital modes of representation, in general. To do this is no more justifiable that it is to study the effective working capacity of men relative to women, in general. Just as there are different kinds of tasks, and also different kinds of men and women, so, also, are there different kinds of communicators and interpreters, and also different kinds of pictures. Thus it could always be claimed for a picture/word study in which a statistically significant difference became manifest, that just the opposite outcome might have resulted if one had done a better job in the selection and arrangement of one's verbal or (depending on the outcome) pictorial sybol vehicles.

6.4.1.2 Other problems. The difficulty in coping with the hard-to-assess effects of codability, is exacerbated by further difficulties, of which we take brief note of three.

6.4.1.2.1 Symbols are independent of their physical parameters for their meaning. It might be supposed that the codability of a referent could be measured by a study of the relevant symbol vehicles. But a characteristic of stimuli that function as symbol vehicles, is that the meaning elicited is independent of the behicle's physical parameters.

Thus, within a broad range, it would not be especially critical just what was the sound level with which one's doctor reported, "Your tumor is benign." This message could be translated into another language, and still convey the same meaning for a bilingual; and the spoken message could even be recoded into an entirely different physical form, as in writing, thereby utilizing an entirely different medium. For literate bilinguals, then, four physically distinctive stimulus situation are all evocative of a single idea.

The meaning of schematized iconic vehicles is also quite highly independent of the physical parameters of those vehicles, though not totally so. If one were to present sundry variations of stick figures of "man" formed of ping pong balls, elves, turtles, and shrunken heads, and if the universe of all normal adults who had previously attained the concept of "man" was asked, "How are these collections alike?", it is likely that many would conceptualize the notion, "man"; and this, even though the vast majority of the physical parameters varied widely across these several collections of diverse objects. Even degree of isomorphicity of visual contour between symbol and referent exemplar can vary within quite broad limits (perhaps those accountable under the notion "stimulus generalization") without interfering with the signification process.

6.4.1.2.2 Realistic pictures are necessarily ambiguous, and so much be schematized for many purposes. Because attention, perception and memory are functionally selective (as see, e.g., Krech, Cruchfield & Ballachey, 1962), and because messages, like any other stimulus material, must be attended to and remembered if they are to have any effect, that which a communicator "puts in" a message (intentional meaning) and that which an interpreter "gets out" of it (functional meaning) are never identical. More importantly, intentional and functional meanings are sometimes incongruous. Brown, Lewis and Harcleroad (1959) have been among those who have explicitly recognized that this is no less the case with pictorial than with verbal symbols.

Along this same line, Hockberg (1962) has shown (a) that in principle, pictures are necessarily ambiguous; (b) that fidelity alone will not allow prediction of what will be seen in a picture (for equally faithful projections of the same object are often far from equal in their portrayal of it); (c) and, therefore, "mechanical measures of representational fidelity are inadequate" (p. 43). Hochberg comments with respect to "potential pictures" (as, e.g., are found in projective tests) as follows: "a picture is defined not by the activity of its creator, but by the intention of the viewer (and partly by the introduction he receives)" (p. 42). The point is most eaily dramatized with respect to "potential pictures," but it is applicable not only across the range of all pictures, but all perception.

The contribution of the interpreter will vary widely, it being high when the stimuli are of the complex unstructures sort used in projective tests. Interpreter contribution will be less high when the pictorial materials are more highly structured, when viewing conditions are optimal, or when the organism is in a low drive state (as Krech, Cruchfield & Ballachey, 1962, summarize the matter in speaking of the determinants of all perception).

6.4.1.2.3 The need for a verbal bridge. If one were to determine the pictorial codability of various concepts, one would have to have some way of assessing the variability of interpretatinn of the symbol vehicles. And this returns us to the report of experiments by Bruner (1964), that was described in the preceding chapter.

The point of those experiments is not, I think, that pictorial representation is useless in teaching concepts—for example, such as the concept "fullest," which was a frequently used one in the described experiments. Rather, it seems to me that the main lesson to be learned is that it is almost unbelievably difficult for an adult to regain his pre-conceptual naivete (Bruner, Goodnow and Austin, 1956), with the result that there is real danger the teacher will assume that concepts can be directly pictured, or that pictured things somehow require no interpretation. (Of course they may not, as in certain circumstances described earlier; but the nature of these circumstances in the tutorial situation involving young children is frequently unknown).

Contrary to what is sometimes supposed, then, I would say that in order to measure pictorial codability--to relate the point vis-a-vis Bruner, to the present context--one's pictures will ordinarily have to be first "translated" to words, and this verbal transformation then quantized by content analytic means. This belief is based on the preceding development, and is summarizable as follows. Meaning is conferred by the interpreters of a symbol, and is not "in" the symbol vehicle. The meaning of a symbol has considerable independence from its physical parameters. Therefore, no quantization of pictorial symbol vehicles in terms of physical parameters (in a way revealing of anything about meaning) is possible. In certain circumstances the meaning of such symbols for an interpreter might be inferred from the interpreter's overt nonverbal behavior. But this is sometimes not possible, and pictorial meaning then has to be inferred from the interpreter's verbal behavior. This last, in any case, is a convenient method in all circumstances.

If this argument is valid, though, what can be said concerning the often stated position that pictures have unique strengths in certain circumstances? Ruesch and Kees (1956) have answered this about as follows. Pictures can convey information not readily conveyed by such discursive means as language, but the test of the success of a pictorial presentation for interpersonal communication is essentially a verbal one. That is, the parties to a communicative act may exchange information through the mechanism of pictorial symbolization, and each may feel illuminated thereby. But whether or not the parties do in fact come to agreement is a matter impossible to establish through further production only of pictorial symbols. In other words, it is not easily demonstrated, except by verbal means, that pictures serve unique functions in interpersonal communication.

It might be thought that we lose something essential in "translating" pictures to words. But all that is intended is that the interpreter's verbal response to pictures be quantized so that this information can be used as a measure in terms of which to more effectively select pictorial stimuli on a later occasion. (We know, of course, that the process of measurement often interferes with the thing measured: thus a sensitive instrument measures an electric current and uses up a little of the current in the process.)

6.4.2 Less Ambitious Approaches to the Study of Pictorial Communication. The research difficulties we have been considering aren't unique to the Pictorial area. For although these difficulties reflect the fact that experimental control is often unattainable here, this shortcoming is not an infrequent one in areas of the social/behavioral realm where empirical data are proving to be cumulative. Thus, more than the noted difficulties in experimental control are involved. The basis of the difficulties we have been stressing arises from the attempt to test differences between iconic and digital modes of representation, in general. What we require, rather than this, are narrow studies of a better defined sort.

6.4.2.1 Content analyses of pictorial/textual messages. I believe that a fruitful way in which to begin to alleviate this sort of difficulty, is through a study of the structure of knowledge in contrasting "realms of meaning" (to use Phenix' phrase). The attempt would be to discover the variations in the uses of different types of visual-iconic representation in these several realms (as was discussed in 6.3). Ideally, an effort such as represented in this monograph would have to be supplemented with an understanding of the structure of knowledge in, let us say, the several disciplines of science. This knowledge, which could be supplied only by scholars in those disciplines, would have to be made available to teams of artists, psychologists, and subject-matter experts so that material could be developed and tested.

But this would seem too big an initial order. Moreover, an easier and a promising approach would seem possible, and probably to be desired as a first, groundbreaking effort. This is an approach using content analytic procedures (e.g., as described by Berelson, 1952). Such procedures would be applied to the analysis of "superior" picture-rich instructional materials. One would begin by describing and illustrating the several types of visual-iconic representation discussed in this monograph, thereby to instruct content judges in how to categorize these various visual-iconic representations as found in the chosen picture-rich sources.

For instance, one might begin by examining such broadly different types of iconic representation as have here been labelled "realistic picture" and "logical picture." The former represent objective features of the phenomenal world, while the latter do not. Another category that would fall in between these, would be one that included the use of pictures to make either a pictorial analogy or a pictorial analogy by extrapolation. In this third type of case, the artist portrays objects in the phenomenal world, but not because of any interest in those particular objects; rather, because of an interest in something else that bears a structural analogy, or analogy of process with the object pictured.

In The Cell (Pfeiffer, 1964), for example, the manner in which opposing muscles cooperate to support or move legs, arms, or other parts of the skeleton, is illustrated by showing a picture of the way two lumberjacks work together to support or move a tree. The tree is analogous to a bone, but it is not intended to look like a bone. The two lumberjacks are analogous to a pair of opposing muscles, but they are not intended to look like muscles. Thus, although such a picture portrays objects in the phenomenal world, these objects are portrayed only in order to show the nature of a structure or process: a process in which the portrayed objects participate in a manner common to the less familiar process (not so readily manifest) in the state of affairs that is of interest.

A number of sub-categories under each of the three broad types of visual-iconic representation mentioned (i.e., the "realistic picture," the "analogical picture," and the "logical picture") suggest themselves. Thus one might begin a pilot analysis with a category-set something like the following.

Realistic Pictures: i.e., pictures to represent the phenomenal world, qua phenomenal world.	Photographs, photographically realistic drawings, etc.
	Optically or mechanically distorted realistic pictures (as in photomicrography).
	Selectively distorted realistic pictures (e.g., as described in 6.3 in connection with the portrayal of a "regularized" cell).
	Schematized pictures.
Analogical Pictures: i.e., pictures to represent the non-phenomenal world through the bridge of the phenomenal world.	Analogical. For instance, the example involving the lumberjacks as illustrated in the text.
	Analogy through extrapolation. For instance, the example in which a fly was compared to the Empire State Building to suggest the length of a micron (in 6.3).

Logical Pictures: i.e., "pictures" to represent the non-phenomenal world (e.g., theories or other logical structures).	Case I: Both the spatial arrangement of object and the order of connection of objects is isomorphic with referent. Case II: Spatial arrangement of objects is arbitrary; order of connection of objects, isomorphic. Case III: Spatial arrangement of objects, isomorphic; order of connection of objects, arbitrary. (See p. 4.3.3)

Ideally, the instructional materials to be content analyzed would come from quite contrasting disciplines. The Life Science Library and the World Book Encyclopedia were mentioned earlier. In the case of both series of publications, the same artistic skills and considerable economic backing have been put behind outstanding scholars in each of several realms of knowledge. If the intuition of the artists and the critical evaluations of the scholars and editors have resulted in the production of pictorial materials of more than average merit in such cases as these, it would be worth while to begin in the manner described. One would need to conduct analyses of pictorial content in several of these areas in a way that would reveal how differences in the structure of ideas was reflected in differences in the use of iconic representation. It would of course be necessary to test the validity of the initial working assumption that the materials chosen made good use of iconic representation.

Initially, the intent would be to be descriptive, and the procedure would be regarded as having more of a potential for suggesting hypotheses than for testing them; although one would have a few rather "common sense" hypotheses from the beginning. For example, one would hypothesize a relatively greater use of logical and analogical pictures in the formal sciences and in the more basic of the natural sciences, and relatively greater use of realistic pictures and little use of logical pictures in the less basic sciences. If my own first impressions from a provisional undertaking along this line provide a reliable clue, it can be expected that the harvest of non-obvious hypotheses from this sort of initial investigative effort will be a rich one.

6.4.2.2 Correlational approaches. The correlational investigation lies midway between the descriptive study such as suggested above, and the much desired but frequently unattainable experimental study. Many studies in psychology and sociology that are described as "experimental" are, in fact, correlational. The major point I would make in this connection--besides noting, as every beginning student is taught, that one cannot infer a casual connection on the basis only of a correlation--is that correlational studies are enormously inefficient unless one is testing some hypothesis or theoretical scheme.

In testing the hypothesis asserting a causal connection between cancer and cigarette smoking, it poved possible to run many correlational studies between the same two factors (smoking and the incidence of lung cancer); and to do this under many different sorts of circumstances with many different categories of people. Because smoking and incidence of lung cancer continued to correlate in this wide assortment of circumstances, evidence of a causal connection between the two variables cumulated. I believe that correlational studies in the pictorial realm have failed to produce results that cumulated, partly because they have seldom been guided by rationalized hypotheses, and partly because series of interrelated correlational investigations have not been systematically pursued.

To suggest one possibility: it was earlier argued that logical pictures could be used to teach the structure of a subject; and that a value of understanding structure was that relative to unorganized knowledge, organized or structured knowledge was easily remembered. With this as one's hypothesis, one might compare textual materials supplemented by a logical picture (that showed the hierarchical connections of the concepts described in the text), with these same textual materials not so supplemented. For reasons already given, one could not directly compare any difference in learning outcome in the text vs. the picture-plus-text condition, but one could compare the rates of forgetting following learning, under the two conditions.

Thus one would test the amount learned by a subject under each of these two conditions immediately following learning. Then one would repeat these measures a second and a third time, taking precautions that the subjects in the two groups were unable to study or rehearse during the interim periods. One would then compare the rates of forgetting as reflected by the changing magnitude of the differences between these pairs of differences. Even if there was no initial mean difference between the two groups of subjects, differences between these pairs of mean differences might emerge with the passage of time.

If the picture-plus-text condition proved to be superior initially, this would not be interpretable relative to the hypothesis. In order for the hypothesis to be confirmed, the magnitude of the pairs of differences would have to increase over time as a result of a slower drop in the picture-plus-text forgetting curve, than in the text-only forgetting curve.

It might be thought that a greater degree of "overlearning" could take place in the text-only, than in the picture-plus-text condition. One might reason that part of the total amount of time available in the picture-plus-text condition would have to be used in order to study the pictorial component, with the result that the text-only condition proved superior. However, this would only show that time spent in study of the picture was time spent inefficiently. The only point this objection could take, then, would be that the procedure outlined yields conservative results.

It would likely be necessary to do a series of such studies in a number of different subject-matter areas, and to employ the skills of a number of communicators. The reasoning here is that already given, except for one additional point; This is that it would not be possible to interpret a negative or a non-significant outcome in the sort of study described. If one got such an outcome, one might assume that the hypothesis was invalid, that the structure of knowledge in the area of interest did not lend itself to hierarchical organization, or that the logical picture was ineptly executed.

There are many variations on the same theme. For instance, one might present text-only materials of a sort logically organizable into a hierarchical structure, and give equated groups of subjects some pre-determined amount of time to study this material. One group would be instructed to learn the structure of the information by ordering the several ideas or concepts hierarchically -- i.e., the subject would be instructed to draw himself a logical picture. Other groups might be given other specific learning sets; yet others, only the general set to study.

Or, to explore another vein, it might be reasoned that the presentation of pictorial materials followed by related verbal materials, is superior to the presentation of these same materials in reverse order. One's reasoning here might be based on presumed differences as regards the simultaneous vs. the successive nature of iconic as compared to digital "reading." The only thing varied would be order: pictorial/verbal vs verbal/pictorial.

6.4.2.3 Measuring pictorial codability. If it could be accomplished, the meaningful pictorial stimuli in ways essentially independent of their physical parameters would be a logically prior task in facilitating the emergence of a science of pictorial communication. The reasoning here is the same throughout the behavioral sciences: response classes cannot be made coordinate with stimulus classes if the stimulus is undefined. The reason that the needed quantization must be largely if not totally independent of physical parameters, follows from the definition of a sub-class of pictures as symbols, and the demonstration that symbol stimuli are largely independent of their physical parameters for their meaning (6.4.1.2.1).

The idea would be to develop standardized pictorial materials whose range of possible interpretations was greatly restricted through schematization, and to measure the codability and the associative strength of these pictorials. The exemplars chosen for picturization would be selected to represent concepts deriving from a rationally determined universe of picturable concepts. The end product would be a standardized set of schematized pictures with age-graded indices of codability and associative strength, that could thereafter be employed in experiments requiring such materials.

The problem can be put this way: given specific concepts having picturable exemplars, and a group of interpreters with homogeneous linguistic histories, can pictorial representations of exemplars of these concepts be found which will make pictorial reference in approximately the same way for this group of interpreters?

And what is the degree of agreement (or conversely, what is the amount of variability) in these judgments for each of the chosen concepts? More concretly, is it possible to find a schematic representation of, say, "man" (e.g., a stick figure) which will fairly consistently elicit the verbal response "man," or a near equivalent?

The overriding problem in the first phase of any investigation such as here proposed, involves sampling concepts from the universe of picturable concepts. (As before, the phrase "picturable concept" is intended to refer to concepts having picturable exemplars.) However, this task may not be so difficult as at first it may seem. Basic English, for instance, employs only 850 carefully selected words, of which 200 are said to name picturable concepts. A likely starting point would be to begin with these 200 concepts, and then to extend this list in terms of information from linguistic science concerning common picturable concepts in the world's languages.

The last-mentioned line of approach could be followed using data such as are suggested by Carroll (1964). Carroll cites a study which compared word frequency lists for English, French, German, and Spanish. It was found that 662 concepts of the 1,000 most frequently named, were concepts common to all four languages. A carefully chosen sample of concepts such as suggested by this list, and by an examination of Basic English, would have to be decided upon. Exemplars of the sample of concepts chosen would then to be pictured in multiple ways. Verbal descriptions of these pictorial exemplars would be recorded and content analyzed in multiple ways to yield several independently-arrived-at measures of codability. (This would be necessary to insure that one or more such measures would meet usual measurement criteria.) The whole of this procedure would have to be repeated in certain instances. In some cases, this might have to be done several times before an adequate picturization of a concept, defined in terms of some acceptable level of codability for a defined age group, would be achieved.

The pictures that survived the above analysis would then be tested for associative strength using several independent measures, and using subjects from several age groups. Such measures have been evolved by the students of verbal learning for measuring the associative strength of words (as, e.g., Cofer, 1961; Cofer & Musgrave, 1963). It is apparent that most of these scaling techniques are useful in the closely analogous task of measuring the associative strength of schematized pictorials (Marshall & Cofer, 1963).

6.5 In Retrospect

I began the just preceding section on measuring pictorial codability with the phrase: "If it could be accomplished. . . ." In truth, it may prove impossible at this point in time to successfully conclude the sort of research proposal described there. I believe that the attempt would prove rewarding, but hopes for any very complete accomplishment may be thirty or more years early.

In 1933, Bloomfield wrote that psychology had nothing to teach the linguist, and that linguistic science would gain most rapidly by forgetting about the users of language in order to concentrate on the description of language, per se. American linguists heeded Bloomfield's words, and with profit. Some thirty years later, though, the cross-disciplinary area of psycho-linguistics began to emerge. Nothing could prevent this. And I think it is instructive to note that the force behind this emergence was not one that resulted primarily because the psychologist finally had something to tell the linguist; but because the linguist, with his careful descriptions of language, had a great deal that was of value to the psychologist.

The point is this: that it may take quite a number of years of preliminary, largely descriptive work, before we can begin to get at the kinds of questions in the realm of pictorial communication we have been trying to get at since the beginning. If any one thing is obvious from all that has gone before in this monograph, it is, I think, that we will get nowhere at all if we fail to work systematically on "small" problems; we must begin to begin by grappling with small problem by small interrelated problem by small interrelated problem.

Notes to Chapter Six

1. This letter is reproduced in full by Hadamard (1945).

2. The content analysis alluded to was carried out by the author's students. The analysis was undertaken largely for didactic purposes, and was never completed in sufficient detail to justify publication.

3. Some of the worst examples of such statements were found in brochures written for teachers by the manufacturers of instructional devices. Some examples: "pictures teach better," "pictures reduce words."

4. Eliot's position on this is presented in Ruesch and Kees (1956).

5. The number of words in the English language depends upon one's definition of "word," and also upon the extent to which one wishes to include highly technical terms. Thus one finds quite different estimates of the size of the English vocabulary.

6. Reported by Bruner, Goodnow and Austin (1956).

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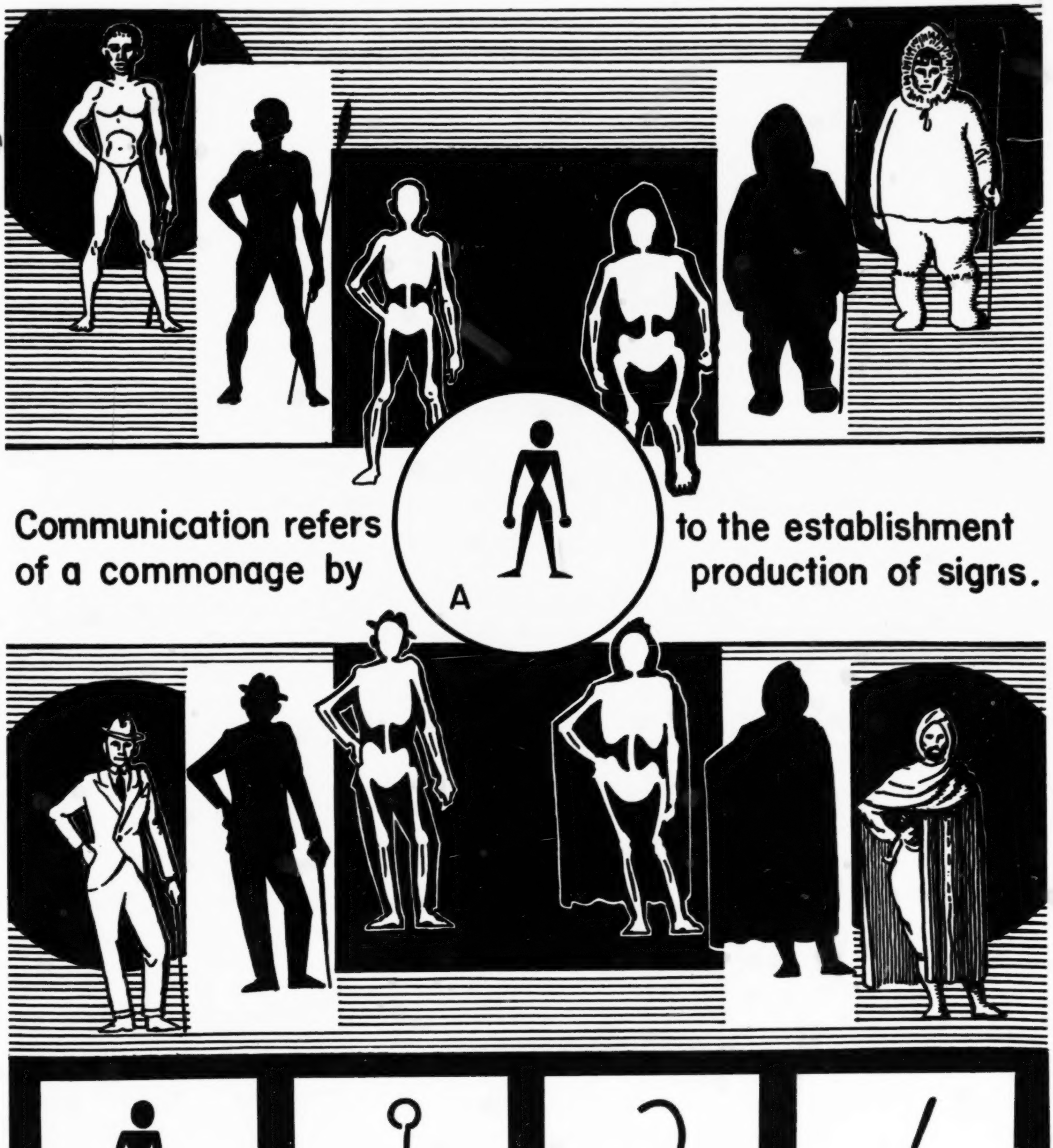
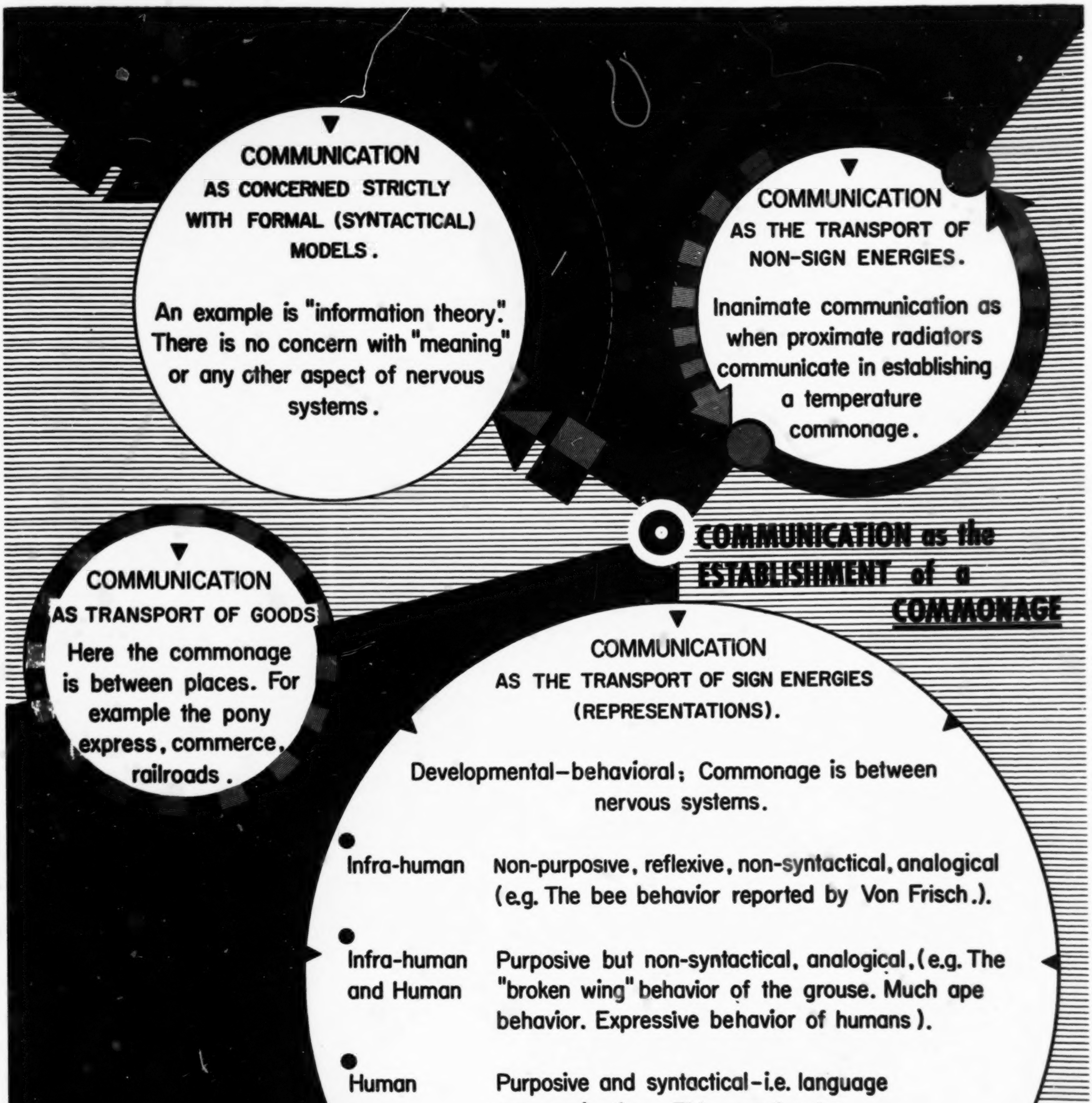


Fig. 2.4 A pictorial verbal abstraction ladder.



COMMUNICATION as the ESTABLISHMENT of a COMMONAGE

COMMUNICATION
AS CONCERNED STRICTLY WITH FORMAL (SYNTACTICAL) MODELS.

An example is "information theory." There is no concern with "meaning" or any other aspect of nervous systems.

COMMUNICATION
AS THE TRANSPORT OF NON-SIGN ENERGIES.

Inanimate communication as when proximate radiators communicate in establishing a temperature commonage.

COMMUNICATION
AS TRANSPORT OF GOODS

Here the commonage is between places. For example the pony express, commerce, railroads.

COMMUNICATION
AS THE TRANSPORT OF SIGN ENERGIES (REPRESENTATIONS).

Developmental-behavioral; Commonage is between nervous systems.

Infra-human	Non-purposive, reflexive, non-syntactical, analogical (e.g. The bee behavior reported by Von Frisch.).
Infra-human and Human	Purposive but non-syntactical, analogical, (e.g. The "broken wing" behavior of the grouse. Much ape behavior. Expressive behavior of humans).
Human	Purposive and syntactical-i.e. language communication. This may involve digital signs: verbal and number signs, Morse Code, flag signaling, etc. analogical signs: pictures, maps, physical models, etc.

Fig. 2.5 Examples of some diverse interpretations of the concept of communication.

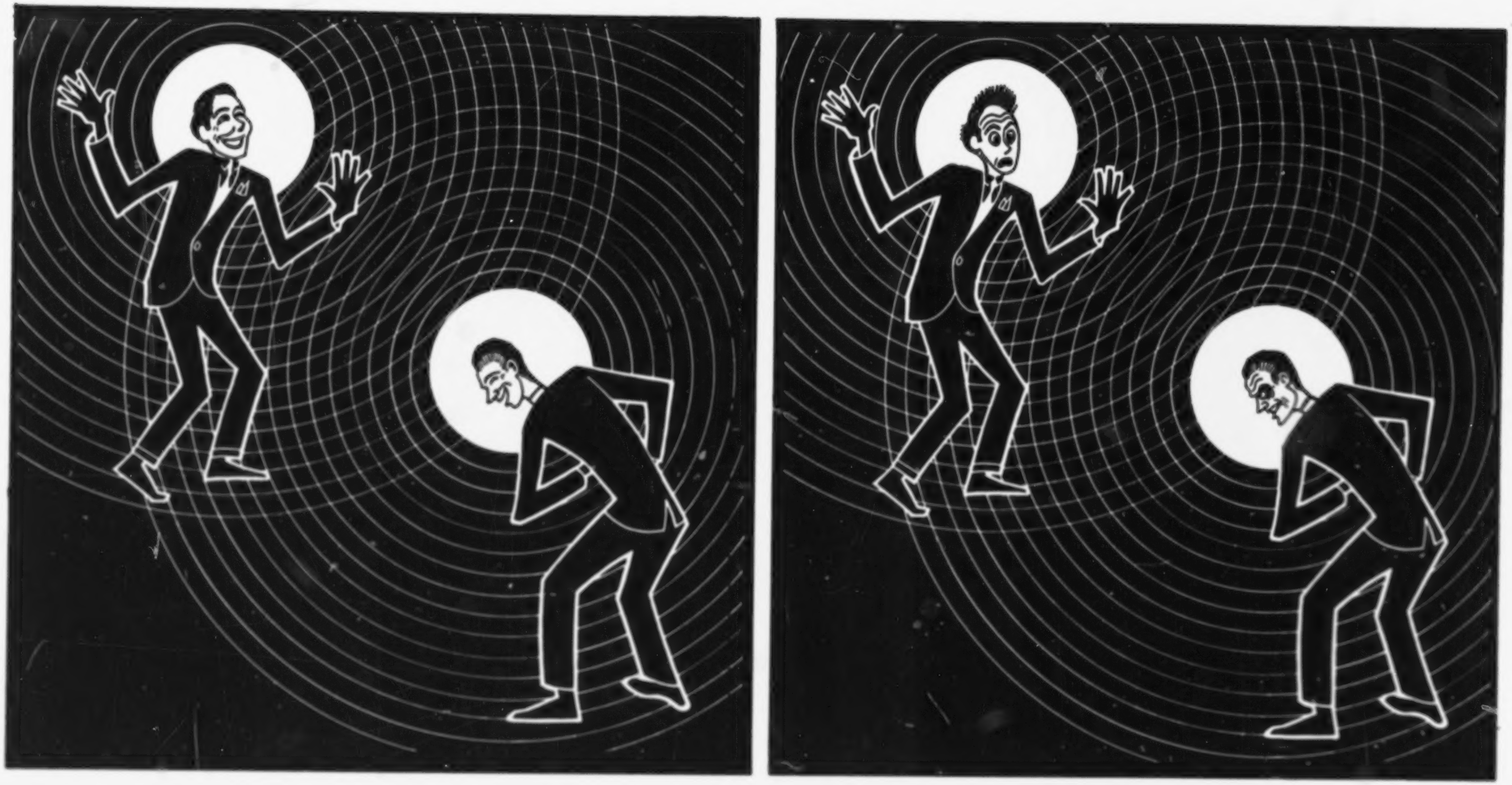


Fig. 2.6 "Meaning" is never transmitted between nerveous systems , only physical energies .

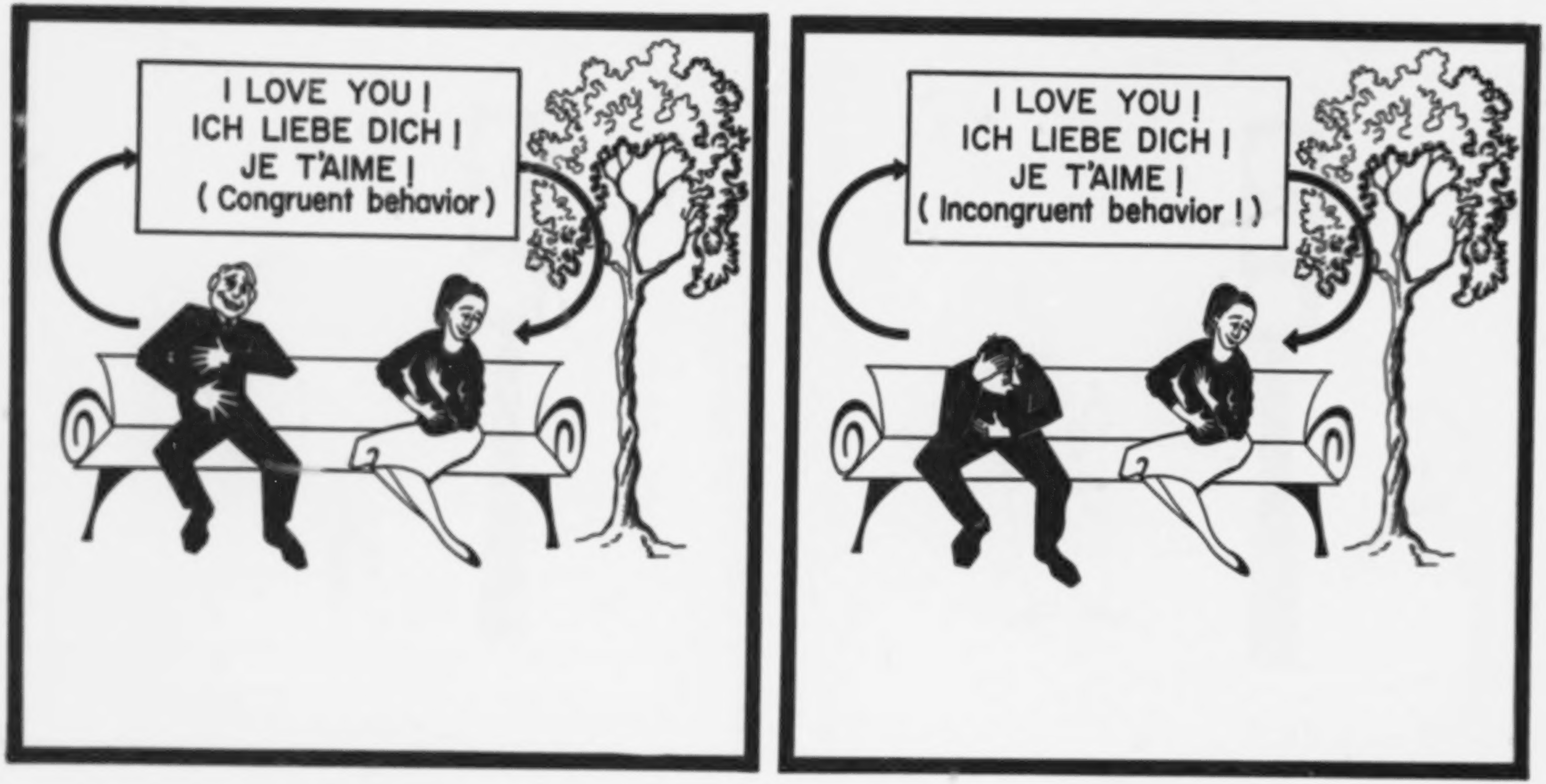

I LOVE YOU !
ICH LIEBE DICH !
JE T'AIME !
(Congruent behavior)
I LOVE YOU !
ICH LIEBE DICH !
JE T'AIME !
(Incongruent behavior !)

Fig. 2.7 Only physical energies are transmitted between persons – never meaning .

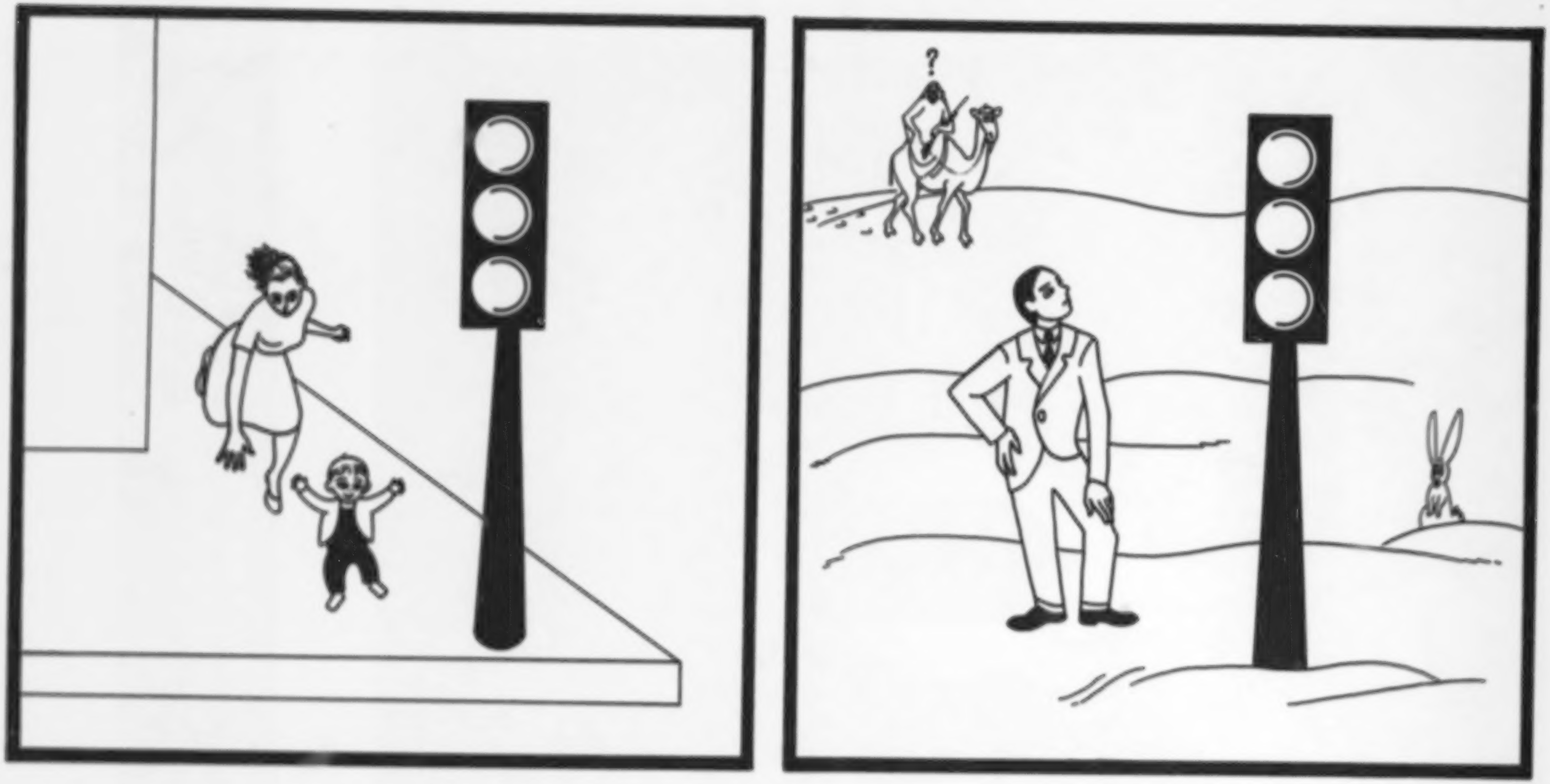


Fig. 2.8 The mere transmission and reception of a physical signal does not constitute communication. A sign, if it is perceived by the individual, has the potential for selecting responses in him.

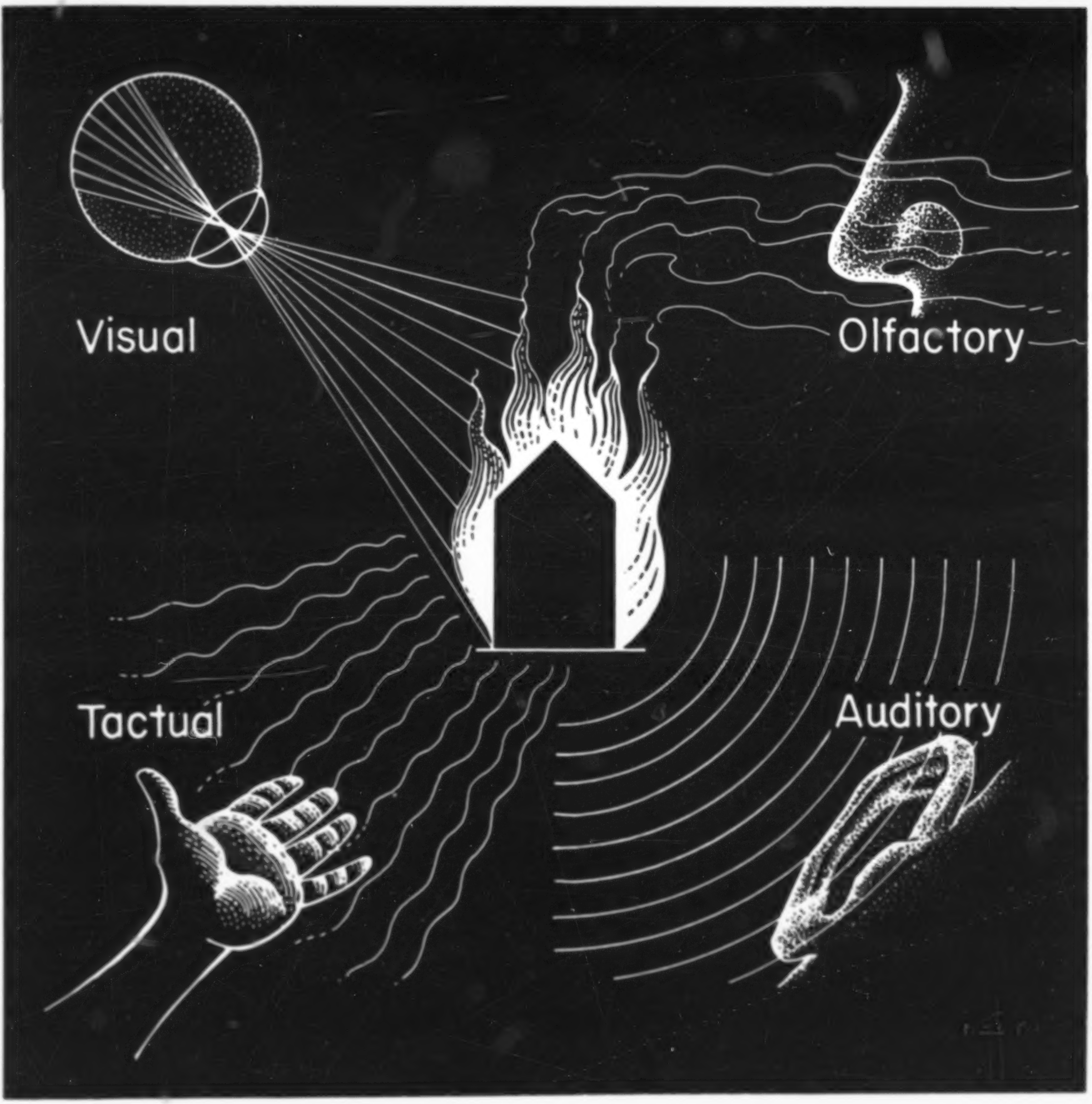


Fig. 2.9 When we communicate we transmit signs. They are visual, auditory, tactual, olfactory – and perhaps other physical energies.

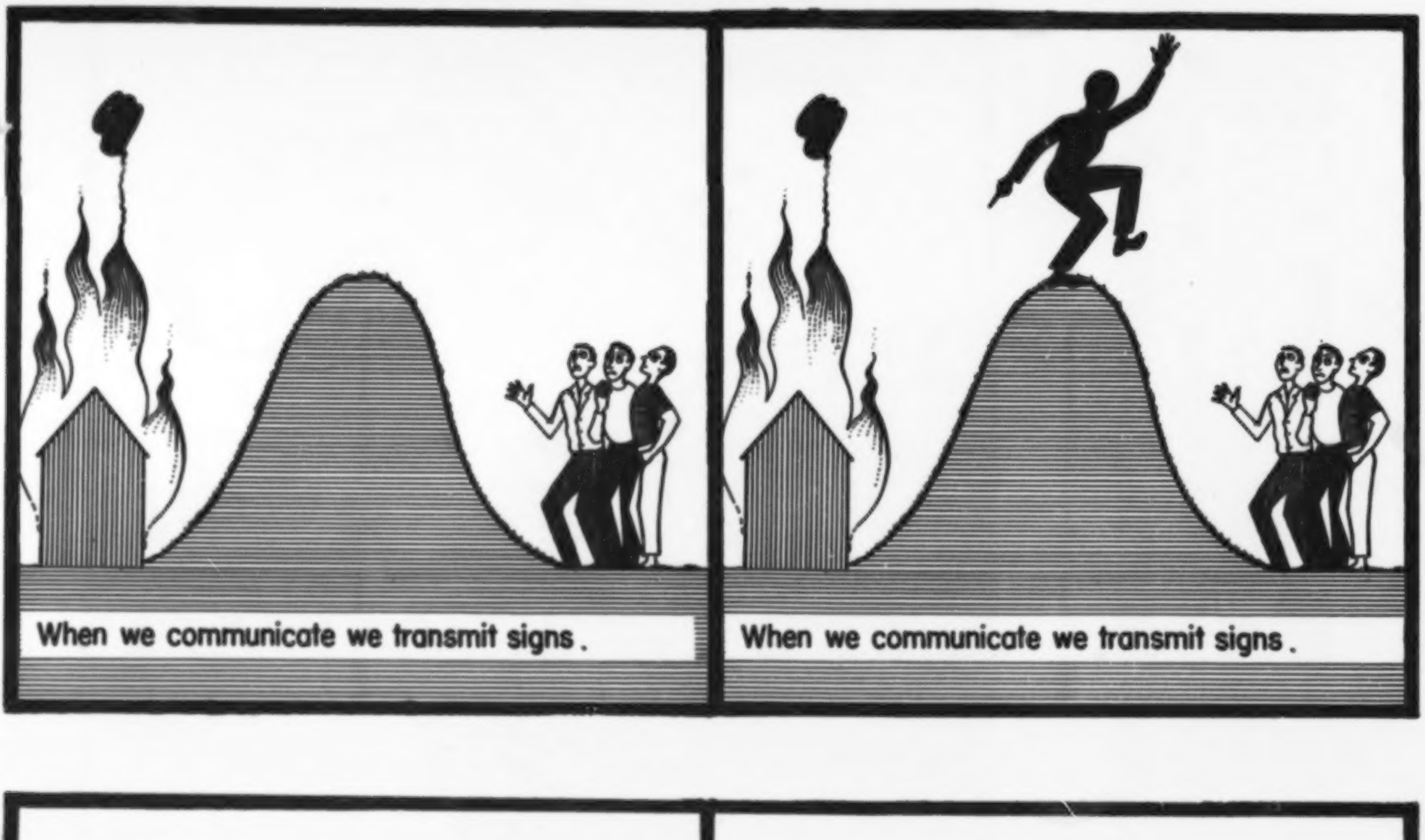

When we communicate we transmit signs.
When we communicate we transmit signs.
When we communicate we transmit signs.
FIRE
When we communicate we transmit signs.

Fig. 2.10 "Communication", as the transmission of signs, may be by speech or writing or by non-verbal gesture.

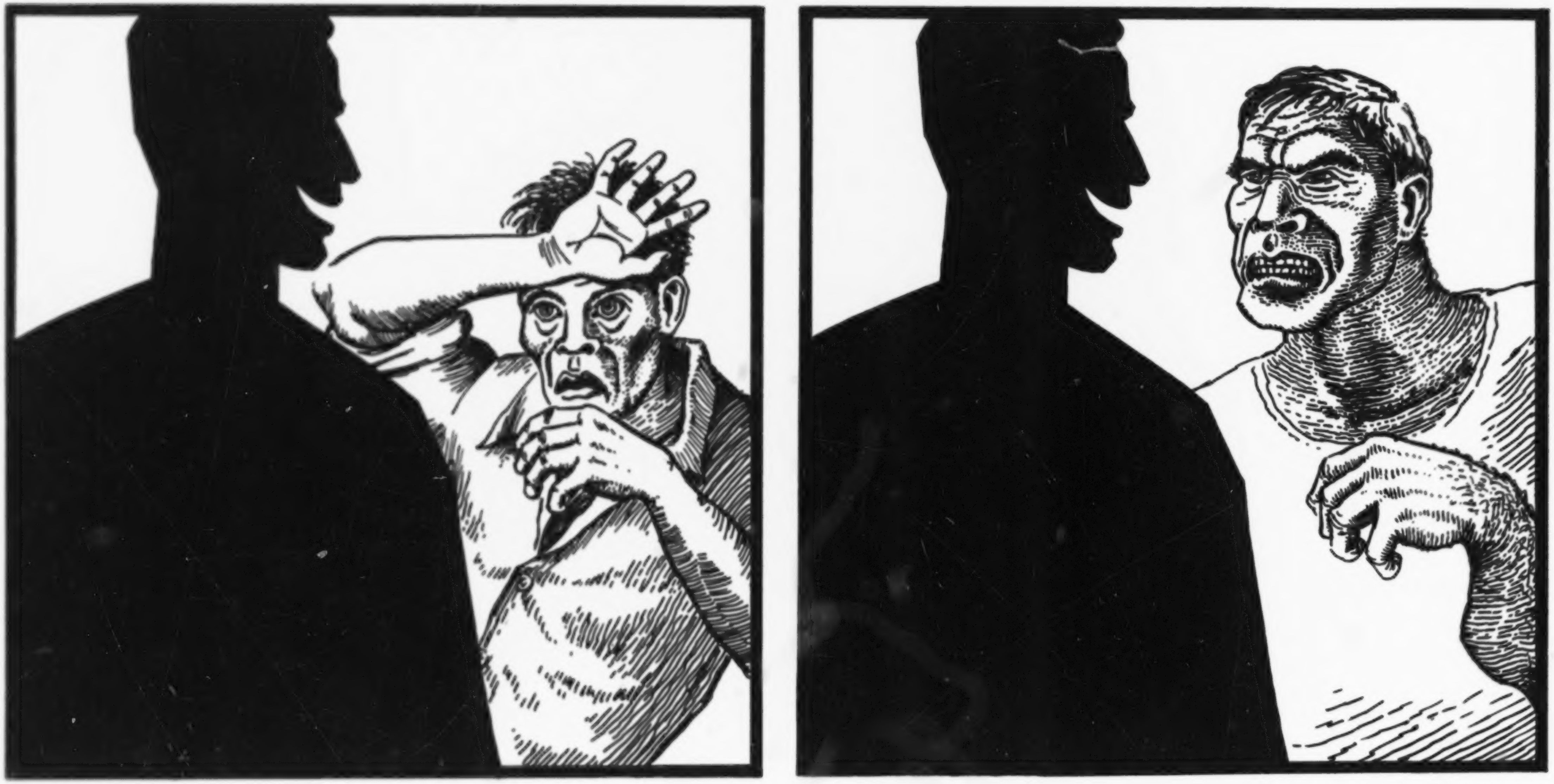


Fig. 2.11 When we communicate, the signs, as physical signals, produce overt and covert responses in the communicatee. The nature of the communication can often be inferred from the responses of the communicatee.

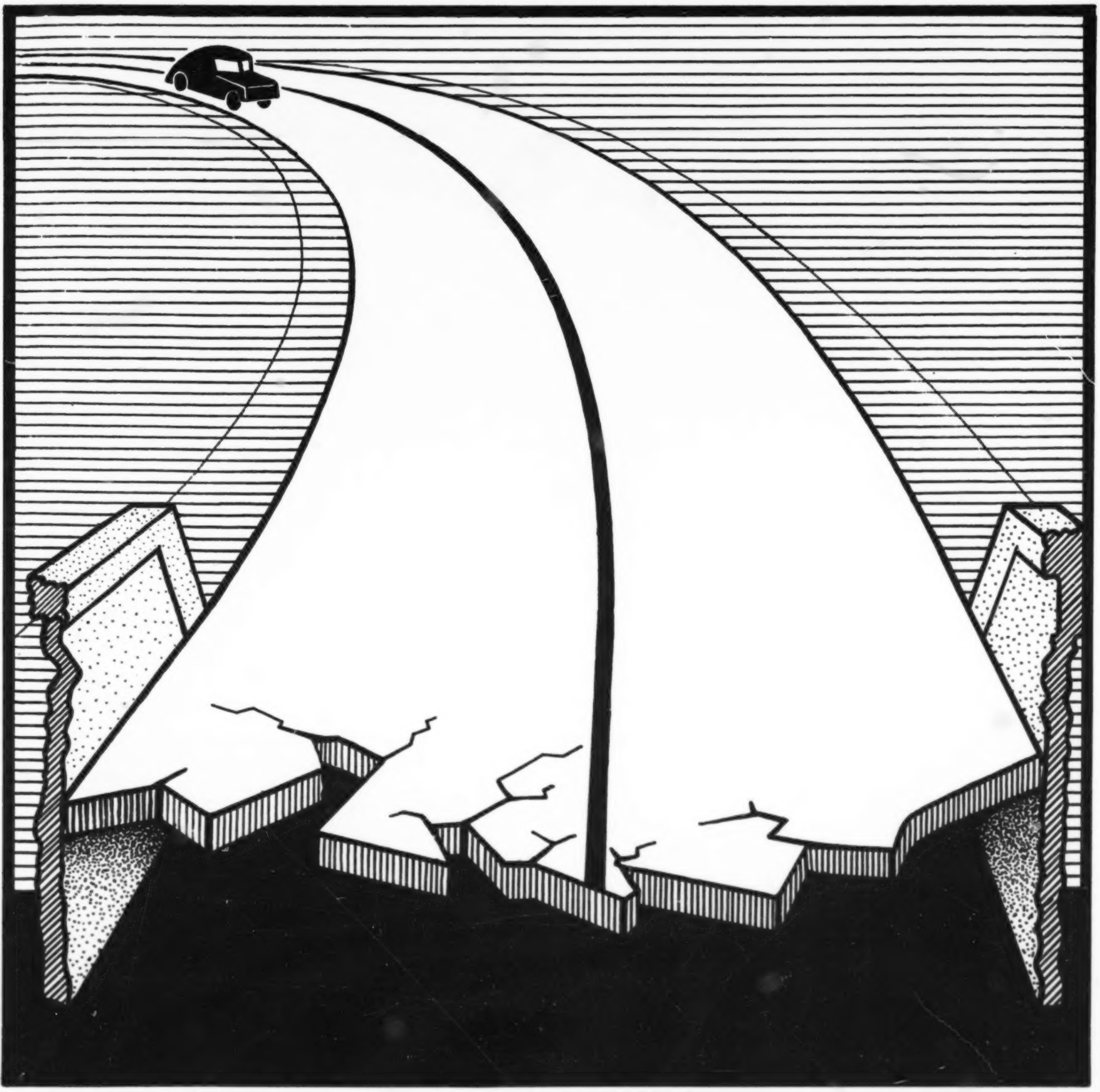


Fig. 2.12 Signs direct behavior with respect to something not at the moment a stimulus. This 'something' is a referent category.

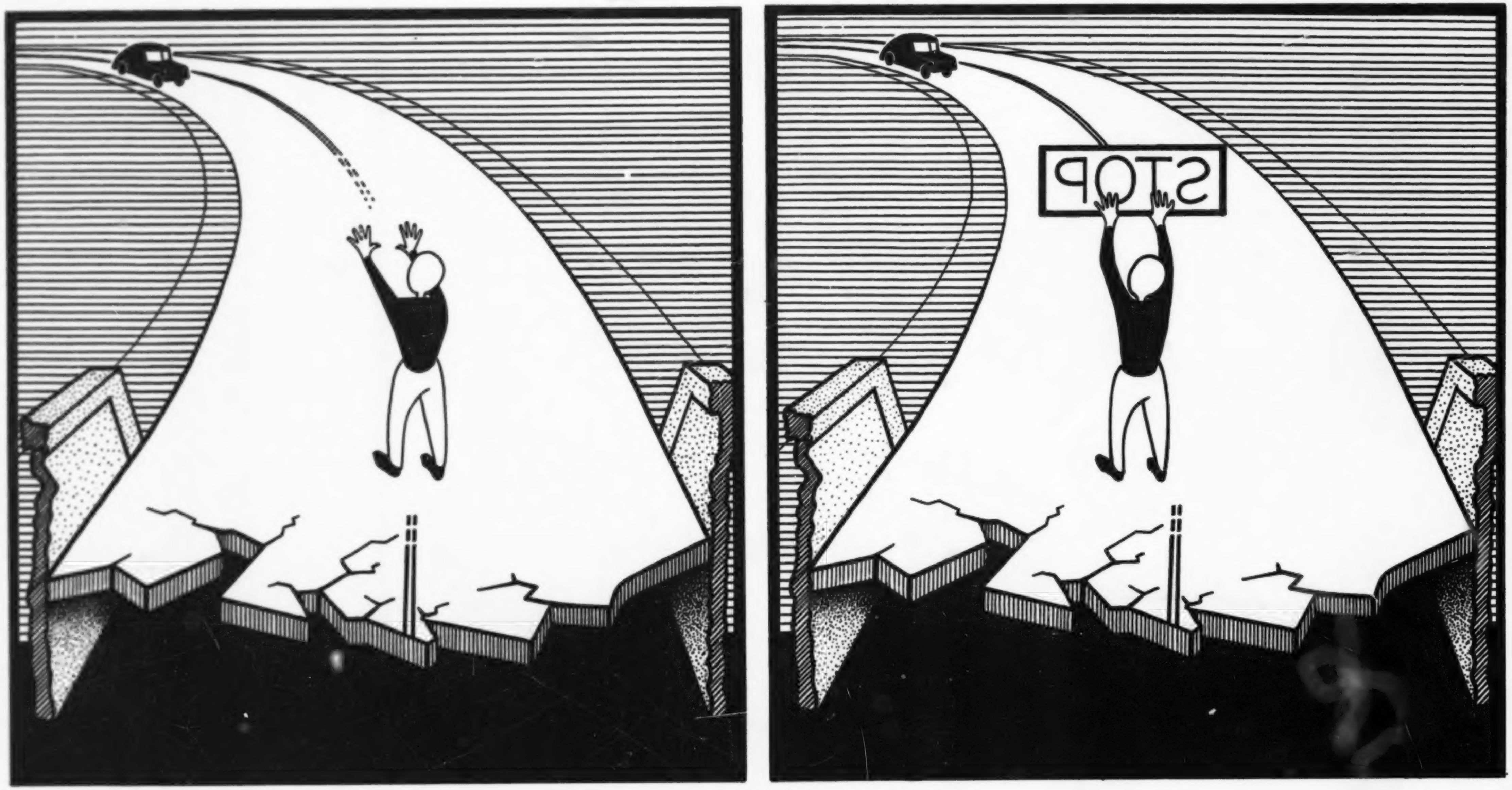


Fig. 2.12 Signs direct behavior with respect to something not at the
(cont.) moment a stimulus. This 'something' is a referent category.

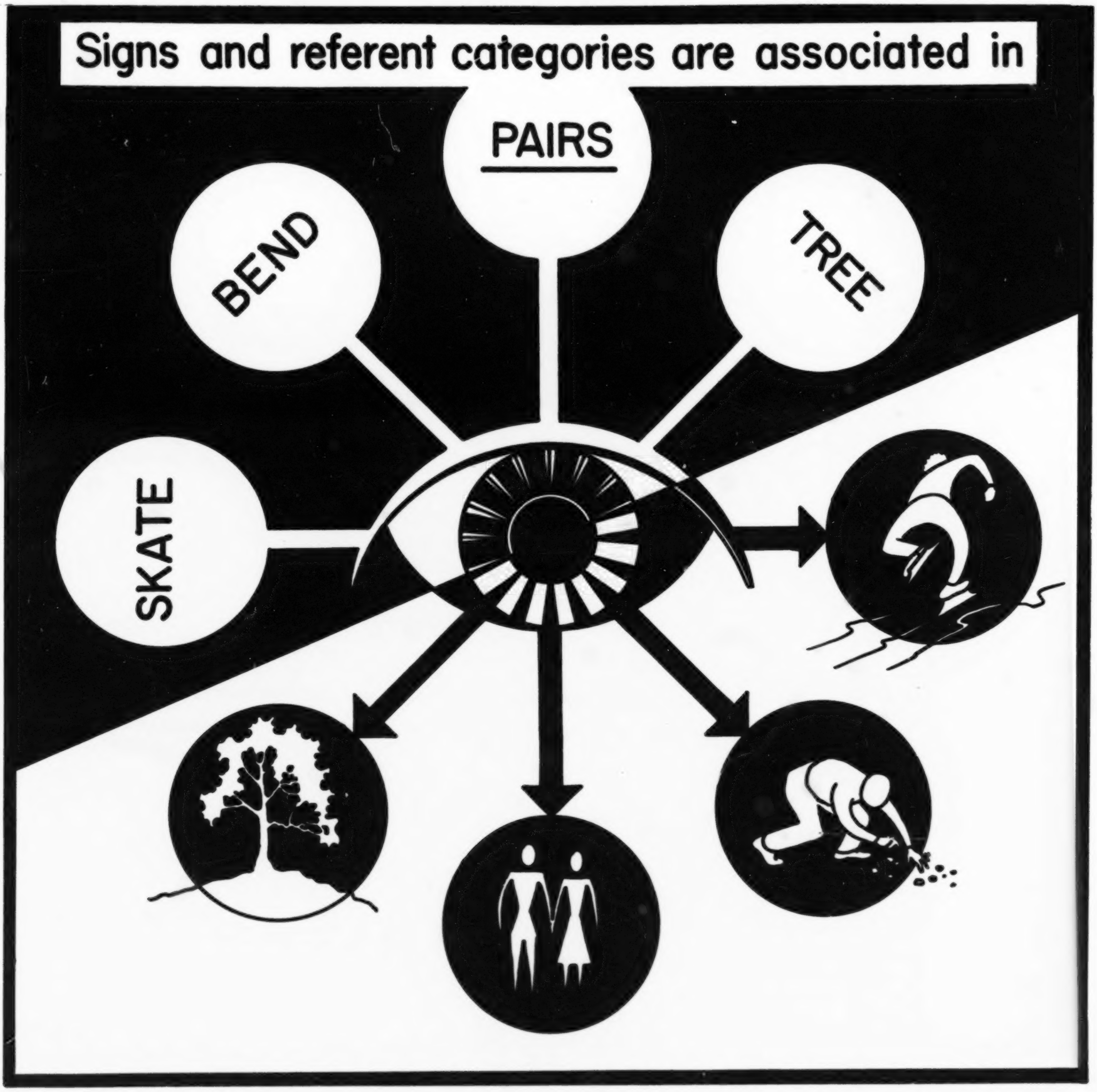
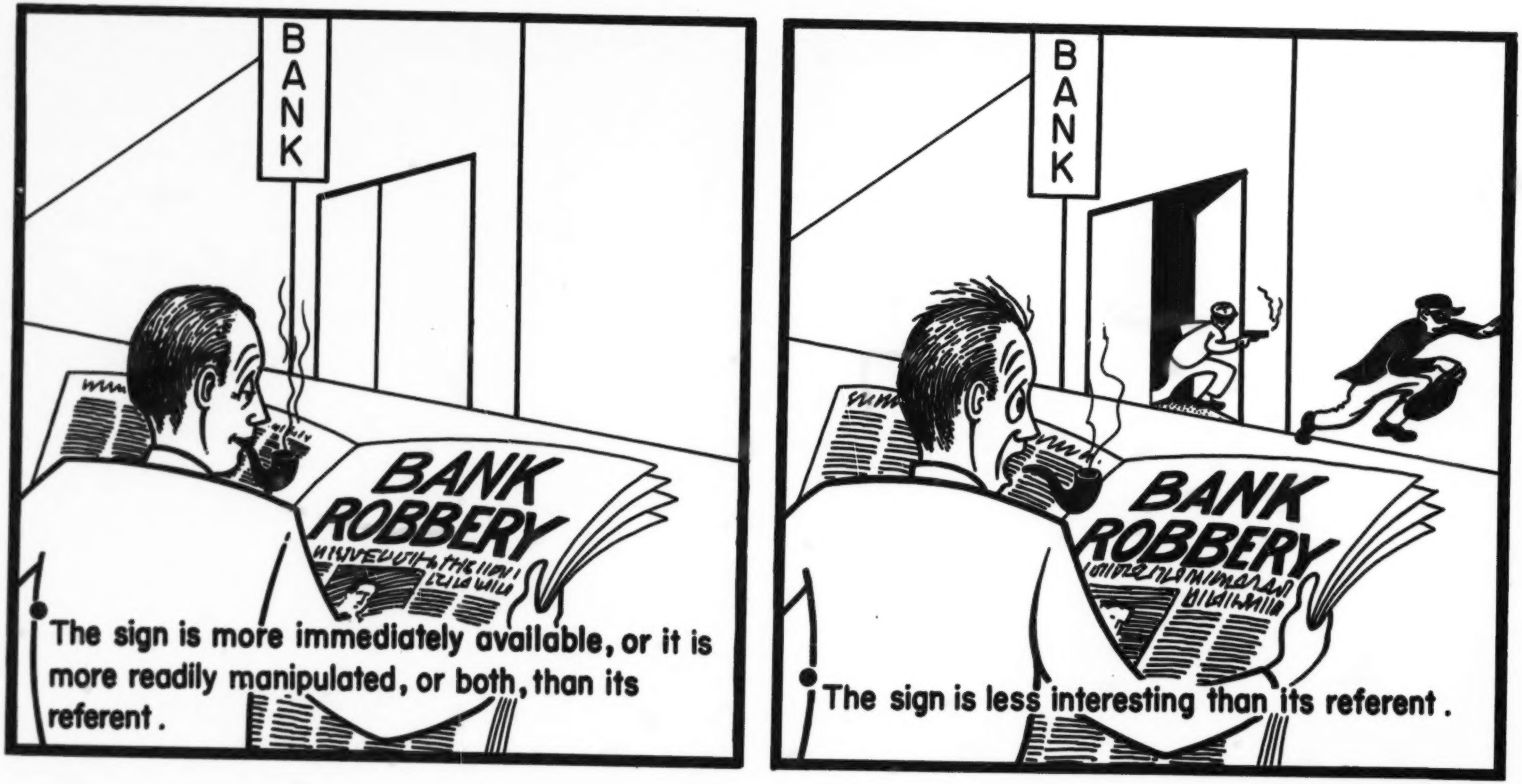


Fig. 2.13 Signs and referent categories are associated in pairs.



The sign is more immediately available, or it is more readily manipulated, or both, than its referent.

The sign is less interesting than its referent.

Fig. 2.14 Signs may be distinguished from their referents in two ways: